Easy to build projects for everyone

JULY 78

40p

Everyday ELECTRONICS

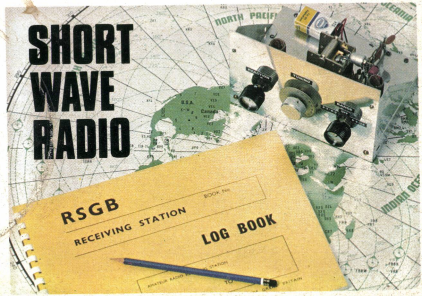
QUAGMIRE GAME

Plus

- AUTO NIGHTLIGHT
- LOGIC PROBE and

POWER SLAVES IN ACTION!

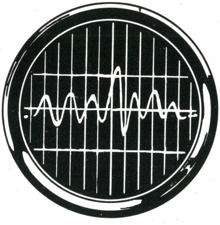
SHORT WAVE RADIO



Australia 75c New Zealand 75c South Africa 70c Malaysia $2·25

LOOK! Here's how you master electronics.

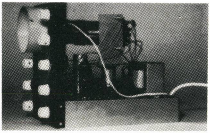
....the practical way.

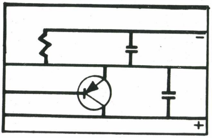


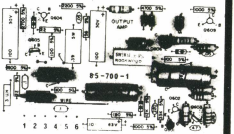
This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.







1 Build an oscilloscope.

As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.

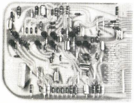
2 Read, draw and understand circuit diagrams.

In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computors and countless other electronic devices and their servicing procedures.

3 Carry out over 40 experiments on basic circuits.

We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v etc.

FREE GIFT



All students enrolling in our courses receive a free circuit board originating from a computer and containing many different components that can be used in experiments and provide an excellent example of current electronic practice.

Free!

To find out more about how to learn electronics in a new, exciting and absorbing way, just clip the coupon for a free colour brochure and full details of enrolment.

British National Radio & Electronic School
P.O. Box 156, Jersey, Channel Islands.

NAME ______________________________

ADDRESS ______________________________

______________________________ Block caps please

ok WIRE WRAPPING CENTRE ok

HOBBY WRAP
Model BW 630

Battery Wire-Wrapping Tool Complete with Bit and Sleeve.

WIRE-WRAPPING TOOL

For .025″ (0,63mm) sq. post "MODIFIED" wrap, positive indexing, anti-overwrapping device.

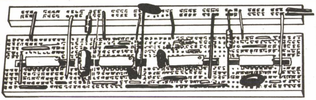
A	For AWG 30	BW-630
B	For AWG 26-28	BW-2628
C	Bit for AWG 30	BT-30
D	Bit for AWG 26-28	BT-2628

A£24·77 B£29·58 C£2·61 D£6·89

3 IN 1 WIRE DISPENSER

New wire dispenser cuts and strips three different colours of wire. Quick and easy to use pocket size.
£3.77

Wire Size: 30 AWG.
50 ft. Red, Blue, White
Kynar insulated.



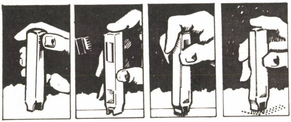
FROM 75p

TERMINAL AND DISTRIBUTION STRIPS

Bread boarding building blocks with universal matrices of solderless plug-in tiepoints.

- Facilitate quick, solderless circuit build-up and check-out on universal .1″ x .1″ matrix.
- Are offered in ten configurations.
- Accept all components with leads up to .032″ diameter.
- Require no special patch cords.
- Includes integral non-shorting instant mounting backing.

DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER

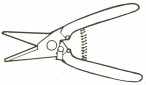


STRAIGHTEN PINS   RELEASE   PICK UP   INSERT

14-16 Pin Dip IC Inserter	INS-1416	£2·58

DIP/IC EXTRACTOR TOOL

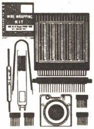
The EX-1 Extractor is ideally suited for hobby enthusiast or lab engineer. Featuring one piece spring steel construction. It will extract all LSI, MSI and SSI devices of from 8 to 24 pins.
Extractor Tool EX-1. **£1·10**



OK PLIERS AND CUTTERS UNIVERSAL CUTTER

Cuts everything. Leather, wire, plastic, tin-plate, cardboard. Stainless steel blades.
Just one of the range of high quality pliers, cutters, tweezers and screwdrivers.

3136 £3·20

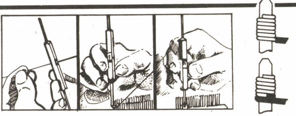


WIRE-WRAPPING KIT

Contains: Hobby Wrap Tool WSU-30 M, Wire Dispenser WD-30-B, (2) 14 DIP's, (2) 16 DIP's, Hobby Board H-PCB-1, DIP/IC Insertion Tool INS-1416 and DIP/IC Extractor Tool EX-1.

Wire-Wrapping Kit	WK-4B (Blue)

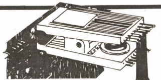
£17·80



HOBBY WRAP TOOL

Wire-wrapping, stripping, unwrapping tool for AWG 30 on .025 (0,63mm) Square Post.

Regular Wrap	WSU-30	£4·39
Modified Wrap	WSU-30M	£4·69



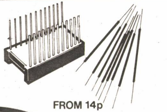
IC TEST CLIPS

FOR DUAL-IN-LINE PACKAGES

- Solve probe attachment problems.
- Simplify prototype and production testing, field service work, and quality control.

£2·75

- Provide full access to integrated circuit DIP leads.
- Remove DIP's damage free.
- Available in sizes to accommodate all DIP's; TC-14 fits 14-pin DIP's etc.



FROM 14p

DIP SOCKET

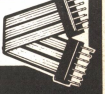
Dual-in-line package, 3 level wire-wrapping, phosphor bronze contact, gold plated pins . 025 (0,63mm) sq., .100 (2,54mm) centre spacing.

14 Pin Dip Socket	14 Dip
16 Pin Dip Socket	16 Dip

ok®

RIBBON CABLE ASSEMBLY FROM £2·70

With 14 Pin Dip Plug - 2″ Long	DE 14-2
With 14 Pin Dip Plug - 4″ Long	DE 14-4
With 14 Pin Dip Plug - 8″ Long	DE 14-8
With 16 Pin Dip Plug - 2″ Long	DE 16-2
With 16 Pin Dip Plug - 4″ Long	DE 16-4
With 16 Pin Dip Plug - 8″ Long	DE 16-8



DISTRIBUTORS WANTED * * *

OK Machine & Tool U.K. Limited

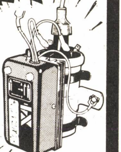
48a The Avenue · Southampton SO1 2SY
Telephone Southampton (0703) 38966/7 Telex 477222 Cablegram OKMAC

DISTRIBUTORS WANTED * * *

The latest kit innovation!

from Sparkrite

Sparkrite—is featured by Shaw Taylor in "DRIVE IN"



the quickest fitting

CLIP ON

capacitive discharge
electronic ignition
in KIT FORM

- **Smoother running**
- **Instant all-weather starting**
- **Continual peak performance**
- **Longer coil/battery/plug life**
- **Improved acceleration/top speeds**
- **Optimum fuel consumption**

Sparkrite X4 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in **1/3 mins.**
Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED

Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions.
NOTE—Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £3.35 inc. VAT. post & packing.

Electronics Design Associates, Dept. EE 7
82 Bath Street, Walsall, WS1 3DE. Phone: (9) 614791

Electronics Design Associates, **Dept. EE 7**
82 Bath Street, Walsall, WS1 3DE. Phone: (9) 614791

Name ....

Address ....

....

Phone your order with Access or Barclaycard

Inc. V.A.T. and P.P.	QUANTITY REQ'D.
X4 KIT £14·95	
TACHS PULSE SLAVE UNIT £3.35	

Send SAE if brochure only required.

I enclose cheque/PO's for

£ ____________

Cheque No.

PLEASE STATE POLARITY POS OR NEG EARTH.

Access or Barclaycard No. ____________

---

the MIGHTY MIDGETS

S-R-B

MINIATURE SOLDERING IRONS AND ACCESSORIES

	RETAIL PRICE each inc. v.a.t.	POSTAGE extra.
18 WATT IRON inc. No. 20 BIT	£3·78	22p
SPARE BITS	44p	—
STANDS	£3·25	65p
SOLDER: SAVBIT 20′	52p	9p
" 10′	26p	4p
LOWMELT 10′	65p	9p
I.C. DESOLDERING BIT	88p	9p

BIT SIZES: No. 19 (1·5 mm) No. 20 (3 mm)
No. 21 (4·5 mm) No. 22 (6 mm)

From your Local Dealer or Direct from Manufacturers

S. & R. BREWSTER LTD

86-88 Union St · Plymouth PL1 3HG

Tel: 0752 65011 TRADE ENQUIRIES WELCOME

TECHNICAL TRAINING IN ELECTRONICS AND TELECOMMUNICATIONS

ICS can provide the technical knowledge that is so essential to your success: knowledge that will enable you to take advantage of the many opportunities open to you. Study in your own home, in your own time and at your own pace and if you are studying for an examination ICS guarantee coaching until you are successful.

City and Guilds Certificates:
Telecommunications Technicians
Radio, TV, Electronics Technicians
Technical Communications
Radio Servicing Theory
Radio Amateurs
Electrical Installation Work
MPT Radio Communications Certificate

Diploma Courses:
Colour TV Servicing
Electronic Engineering and Maintenance
Computer Engineering and Programming
Radio, TV, Audio Engineering and Servicing
Electrical Engineering, Installation and Contracting

POST OR PHONE TODAY FOR FREE BOOKLET

ICS To: International Correspondence Schools

Dept 268W Intertext House, London
SW8 4UJ or telephone 622 9911

Subject of Interest ....

Name ....

Address ....

.... Tel: .... Age: ....

BOOKS AND COMPONENTS

BOOKS BY BABANI

Purchase books to the value of £5.00 from the list below and choose any 60p pak from this page *FREE*.

BP2	Handbook of Radio, TV & Industrial & Transmitting Tube & Valve Equivalents	**60p†**
BP3	Handbook of Tested Transistor Circuits	**40p†**
BP6	Engineers and Machinists Reference Tables	**40p†**
BP7	Radio & Electronic Colour Codes and Data	**15p†**
BP10	Modern Crystal and Transistor Set Circuits for beginners	**95p†**
BP15	Constructors Manual of Electronic Circuits for the Home	**50p†**
BP16	Handbook of Electronic Circuits for the Amateur Photographer	**60p†**
BP18	Boys and Beginners Book of Practical Radio and Electronics	**60p†**
BP22	79 Electronic Novelty Circuits	**75p†**
BP23	First book of Practical Electronic Projects	**75p†**
BP24	52 Projects Using IC741 (or equivalents)	**75p†**
BP26	Radio Antenna Handbook for Long Distance Reception and Transmission	**85p†**
BP27	Giant Chart of Radio Electronic Semiconductor and Logic Symbols	**60p†**
BP29	Major Solid State Audio Hi-Fi Construction Projects	**85p†**
BP32	How to Build Your Own Metal & Treasure Locators	**85p†**
BP34	Practical Repair & Renovation of Colour TVs	**95p†**
BP35	Handbook of IC Audio Preamplifier & Power Amplifier Construction	**95p†**
BP36	50 Circuits Using Germanium, Silicon & Zener Diodes	**75p†**
BP37	50 Projects Using Relays, SCR's and TRIACS	**£1·10†**
BP39	50 (FET) Field Effect Transistor Projects	**£1·25†**
129	Universal Gram-motor Speed Indicator	**8p†**
160	Coil Design and Construction Manual	**75p†**
161	Radio, TV and Electronics Data Book	**60p†**
196	AF-RF Reactance—Frequency Chart for Constructors	**15p†**
202	Handbook of Integrated Circuits (ICs) Equivalents and Substitutes	**75p†**
205	First Book of Hi-Fi Loudspeaker Enclosures	**75p†**
213	Electronic Circuits for Model Railways	**85p†**
214	Audio Enthusiasts Handbook	**85p†**
216	Electronic Gadgets and Games	**85p†**
217	Solid State Power Supply Handbook	**85p†**
219	Solid State Novelty Projects	**85p†**
220	Build Your Own Solid State Hi-Fi and Audio Accessories	**85p†**
222	Solid State Short Wave Receivers for Beginners	**95p†**
223	50 Projects Using IC CA3130	**95p†**
224	50 CMOS IC Projects	**95p†**
225	A Practical Introduction to Digital IC's	**95p†**
226	How to Build Advanced Short Wave Receivers	**£1·20†**
RCC	Resistor Colour Code Disc Calculator	**10p†**

BOOKS BY NEWNES

No. 229 Beginners Guide to Electronics	Price **£2·25†**
No. 230 Beginners Guide to Television	Price **£2·25†**
No. 231 Beginners Guide to Transistors	Price **£2·25†**
No. 233 Beginners Guide to Radio	Price **£2·75†**
No. 234 Beginners Guide to Colour Television	Price **£2·25†**
No. 235 Electronic Diagrams	Price **£1·80†**
No. 236 Electronic Components	Price **£1·08†**
No. 237 Printed Circuit Assembly	Price **£1·08†**
No. 238 Transistor Pocket Book	Price **£3·90†**
No. 225 110 Thyristor Projects Using SCRs & Triacs	Price **£2·50†**
No. 227 110 COS/MOS Digital IC Projects For the Home Constructor	Price **£2·25†**
No. 226 110 Operational Amplifier Projects for the Home Constructor	Price **£2·50†**
No. 242 Electronics Pocket Book	Price **£3.90†**
No. 239 30 Photoelectric Circuits & Systems	Price **£1·80†**

NUTS AND BOLTS

BA BOLTS – packs of BA threaded cadmium plated screws slotted cheese head.

Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in OBA	839	**£1·20**	½in 4BA	846	**£0·32**
½in OBA	840	**£0·75**	¼in 4BA	847	**£0·25**
1in 2BA	842	**£0·65**	1in 6BA	848	**£0·40**
½in 2BA	843	**£0·45**	½in 6BA	849	**£0·21**
¼in 2BA	844	**£0·52**	¼in 6BA	850	**£0·25**
1in 4BA	845	**£0·44**			

BA NUTS – packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	855	**£0·72**	4BA	857	**£0·30**
2BA	856	**£0·48**	6BA	858	**£0·24**

BA WASHERS – flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	859	**£0·14**	4BA	861	**£0·12**
2BA	860	**£0·12**	6BA	862	**£0·12**

SOLDER TAGS – hot tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	851	**£0·40**	4BA	853	**£0·22**
2BA	852	**£0·28**	6BA	854	**£0·22**

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	**£0·11•**
DPDT standard slide	1974	**£0·14•**
Toggle switch SPST 1½ amp 250V a.c.	1975	**£0·33•**
Toggle switch DPDT 1 amp 250V a.c.	1976	**£0·42•**
Rotary on-off mains switch	1977	**£0·50•**
Push switch – Push to make	1978	**£0·13•**
Push switch – Push to break	1979	**£0·18•**

ROCKER SWITCH	**Colour**	**No.**	**Price**
A range of rocker	RED	1980	**£0·26•**
switches SPST – moulded	BLACK	1981	**£0·26•**
in high insulation.	WHITE	1982	**£0·26•**
Material available in a	BLUE	1983	**£0·26•**
choice of colours ideal	YELLOW	1984	**£0·26•**
for small apparatus.	LUMINOUS	1985	**£0·26•**

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	**£0·50•**
Miniature SPST toggle, 2 amp 250V a.c.	1959	**£0·55•**
Miniature DPDT toggle, 2 amp 250V a.c.	1960	**£0·70•**
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	**£0·85•**
Push button SPST, 2 amp 250V a.c.	1962	**£0·78•**
Push button SPST, 2 amp 250V a.c.	1963	**£0·83•**
Push button DPDT, 2 amp 250V a.c.	1964	**£0·98•**

MIDGET WAFER SWITCHES

Single-bank wafer type – suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactiver loads make-before-break contacts. These switches have a spindle 0·25in dia. and 30° indexing.

Description	Order No.	Price
1 pole 12 way	1965	**£0·48•**
2 pole 6 way	1966	**£0·48•**
3 pole 4 way	1967	**£0·48•**
4 pole 3 way	1968	**£0·48•**

MICRO SWITCHES	**Order No.**	**Price**
Plastic button gives simple on-off action Rating 10 amp 250V a.c.	1969	**£0·20**
Button gives 1 pole change over action Rating 10 amp 250V a.c.	1970	**£0·25**

FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	**£0·07•**
1¼in x ¼in chassis mounting	507	**£0·12•**
1¼in car inline type	508	**£0·15•**
Panel mounting 20mm	509	**£0·20**
Panel mounting 1¼in	510	**£0·30**

QUICK BLOW 20mm

Type	No.	Type	No.	Type	No.
150mA	611	1A	615	3A	619
250mA	612	1·5A	616	4A	620
550mA	613	2A	617	5A	621
800mA	614	2·5A	618		

All **5p** each excepting 616 which is **7p.**

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1·6A	627	5A	630

All 7p each

QUICK BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	4A	641
1·6A	636	3A	639	5A	642
2A	637				

All 6p each

CASES AND BOXES

INSTRUMENT CASES. In two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5½in	2in	**£1·52•**
156	11in	6in	3in	**£2·12•**
157	6in	4¾in	1¾in	**£1·30•**
158	9in	5¼in	2½in	**£1·76•**

ALUMINIUM BOXES. Made from bright ali., folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	**62p•**
160	4in	4in	1½in	**62p•**
161	4in	2¼in	1½in	**62p•**
162	5¼in	4in	1½in	**74p•**
163	4in	2½in	2in	**64p•**
164	3in	2in	1in	**44p•**
165	7in	5in	2½in	**£1·04•**
166	8in	6in	3in	**£1·32•**
167	6in	4in	2in	**86p•**

MIDGET WAFER SWITCHES

1965 – 1 pole 12 way	**48p•**
1966 – 2 pole 6 way	**48p•**
1967 – 3 pole 4 way	**48p•**
1968 – 4 pole 3 way	**48p•**

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	**90p•**
2022	9V-0-9V 100mA	**90p•**
2023	12V-0-12V 100mA	**95p•**

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	**£1·50•**
2025	MT150-0-12V, 0-12V RMS	**£1·50•**

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	**£2·50•**	P. & P. 45p
2027	9V-0-9V 1 amp	**£2·00•**	P. & P. 45p
2028	12V-0-12V 1 amp	**£2·60•**	P. & P. 55p
2029	15V-0-15V 1 amp	**£2·75•**	P. & P. 66p
2030	30V-0-30V 1 amp	**£3·45•**	P. & P. 86p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

Voltages available by use of taps:
4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25-0-25V.

No.	Rating	Price	
2031	½ amp	**£5·50•**	P. & P. 86p
2032	1 amp	**£6·60•**	P. & P. 86p
2033	2 amp	**£8·40•**	P. & P. £1·10

AUDIO LEADS

107	FM Indoor Ribbon Aerial	**£0·60•**
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	**£0·75•**
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	**£0·85•**
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	**£0·85•**
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	**£1·10•**
117	AC mains connecting lead for cassette recorders & radios. 2 metres	**£0·68•**
118	5 pin DIN phono plug to stereo headphone jack socket	**£1·05•**
119	2+2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	**£0·90•**
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	**£0·60•**
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	**£1·50•**
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	**£0·75•**
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	**£0·75•**
126	5 pin DIN plug to Tinned open end. Length 1.5m	**£0·75•**
127	5 pin Din plug to 4 Phono Plugs. All colour coded. Length 1.5m	**£1·30•**
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	**£0·80•**
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	**£1·05•**
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	**£0·68•**
131	5 pin DIN plug to 3 pin DIN plug. 1&4 and 3&5. Length 1.5m	**£0·83•**
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	**£0·98•**
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	**£0·75•**
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	**£0·68•**
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	**£0·68•**
136	Coiled stereo headphone extension lead. Black. Length 6m	**£1·75•**
178	AC mains lead for calculators etc.	**£0·68•**

E.E.TEACH-IN-KIT

STILL AVAILABLE

A FULL KIT OF PARTS (LESS BATTERIES) TO ENABLE YOU TO COMPLETE ALL THE PROJECTS IN THIS COURSE ONLY £11·50 incl. V.A.T. & P & P.

BI-PAK CATALOGUE

NEW EDITION NOW AVAILABLE

Send for your copy of our revised catalogue and price list NOW! It contains 127 pages packed with literally hundreds of semiconductors, components and our famous range of BI-KITS audio modules.

ONLY 65p POST FREE

ORDERING Do not forget to state order number and your name and address.

V.A.T. Add 12½% to prices marked•, 8% to those unmarked. Items marked are zero rated.

P&P. 35p unless otherwise shown.

BI-PAK

DEPT. EE7, P.O. Box 6, Ware, Herts
COMPONENTS SHOP: 18 BALDOCK
STREET, WARE, HERTS.

FREE CATALOGUE/ORDER FORM
SEND S.A.E

700+ Top quality components for the beginner and expert alike. Despatched by return (1st Class for small packets) subject to availability. Discounts. 5% above £5, and 10% above £20.

741 ONLY **30p** | **555** ONLY **50p** | **TIL209** ONLY **15p** | **IN4001** ONLY **5p**

ACE

Components below are a small sample from our range. Many more semiconductors available. Additionally we can supply priced component lists for all E.E. projects from Oct 77 onwards. Send SAE for up to four. Let us quote you for any requirements—Export welcome.

Capacitors Electros-Axial Value (μF)

1/63V	10p
2·2/63V	10p
4·7/63V	10p
10/63V	10p
10/25V	10p
22/25V	10p
47/25V	10p
100/63V	25p
100/25V	10p
220/25V	25p
470/63V	37p
470/25V	34p
1000/63V	46p
1000/25V	54p
2200/25V	85p

Tantalum

0·47/35V	14p
1·0/35V	14p
2·2/35V	16p
4·7/35V	17p
10/25V	21p
22/16V	24p
47/6·3V	24p

Polyester-Radial

0·001	7p
0·0022	7p
0·0047	7p
0·01	7p
0·022	7p
0·047	7p
0·1	8p
0·22	9p
0·47	18p
1·0	18p
2·2	36p

Polystyrene Value (pF)

10	6p
22	6p
33	6p
47	6p
100	6p
150	6p
220	6p
330	6p
470	6p
680	6p
1000	6p
1500	6p
2200	6p
3300	6p
4700	9p
10000	9p

Ceramics 50V (Pack 3) 10p

22
33
47
100
150
220
270
330
470
560
1000
2200
4700
0·01μF
0·022μF
0·047μF

Cases Polystyrene

MB1	58p
MB2	69p
MB3	83p

Vero Cases 75 Series

1410	390p
1411	430p
1412	555p
1237	240p
1238	300p
1239	350p
1798	450p

65 Series

2514	180p
2516	210p
2518	230p
2520	260p
2522	340p
2523	690p

Vero Boards 0·1″

2·5″×3·75″	50p
3·75″×3·75″	59p
2·5″×5″	59p
3·75″×5″	66p

Dec & Blob

S. Dec	216p
T. Dec	399p

Blob 0·1″

2·5″/5″	33p
2·5″/3·75″	25p
3·75″/5″	50p

LEDS

TIL209R	15p
TIL209G	35p
TIL209Y	35p
LED0·2″R	15p
LED0·2″G	35p
LED0·2″Y	35p
DL707	100p

I.C. SKTS

8 PIN DIL	21p
14 PIN DIL	24p
16 PIN DIL	27p

Resistors ¼W (Packs of 3) 6p

Carbon Film 5%
1Ω-10MΩ
E12 Values

Presets

Min. Horiz. 8p
100Ω-2·2MΩ (at 1, 2·2+4·7 decades)

Min. Vert. 8p
100Ω-1MΩ (at 1, 2·2 + 4·7 decades)

Transistors

AC126	20p
AC127	20p
AC128	27p
AC141	21p
AC142	21p
AC176	28p
AC187	21p
AC188	21p
AC187/8MP	53p
AC187K	21p
AC188K	21p
AD149	79p
AD161	75p
AD162	75p
AD161/2 MP	160p
AF127	36p
AF139	48p
AF239	52p
BC107	13p
BC108	13p
BC109	13p
BC126	20p
BC140	35p
BC142	30p
BC143	30p
BC147	10p
BC148	10p
BC149	11p
BC154	16p
BC157	12p
BC158	12p
BC159	15p
BC161	32p
BC167	12p
BC168	11p
BC169	12p
BC170	16p
BC171	11p
BC172	13p
BC173	14p
BC177	19p
BC178	19p
BC179	19p
BC182L	11p
BC183L	11p
BC184L	11p
BC186	25p
BC187	27p
BC207	11p
BC208	11p
BC209	11p
BC212L	11p
BC213L	11p
BC214L	11p
BC237	16p
BC238	16p
BC239	16p
BC301	32p
BC303	32p
BC307	11p

Transistors

BC308	12p
BC309	12p
BC327	17p
BC328	15p
BC337	15p
BC338	15p
BC441	34p
BC461	36p
BC547	13p
BC548	13p
BC549	14p
BC557	16p
BC558	15p
BC559	15p
BCY70	20p
BCY71	20p
BCY72	16p
BD115	54p
BD123	80p
BD124P	90p
BD131	68p
BD132	70p
BD131/2MP	140p
BD133	50p
BD135	41p
BD136	39p
BD137	40p
BD138	45p
BD139	42p
BD140	47p
BF180	35p
BF181	35p
BF194	13p
BF195	13p
BF196	13p
BF197	13p
BFX84	24p
BFX87	29p
BFX88	29p
BFY50	23p
BFY51	23p
BFY52	23p
BSX20	21p
MJ480	125p
MJ481	155p
MJ490	137p
MJ491	173p
MJ2501	246p
MJ3001	205p
MJE340	49p
MJE520	51p
MJE2955	99p
MJE3055	85p
MPF102	40p
OC28	120p
OC35	81p
OC70	35p
OC71	16p
OC81	35p
TIP31A	42p
TIP32A	44p
TIP41A	59p
TIP42A	59p
TIP2955	104p
TIP3055	65p
TIS43	35p
ZTX107	14p
ZTX108	14p
ZTX109	14p
ZTX300	17p
ZTX500	18p
2N697	22p
2N706	18p
2N1131	30p
2N1132	30p
2N1613	24p

Transistors

2N1711	24p
2N1893	25p
2N2219	29p
2N2369A	22p
2N2646	92p
2N2905	28p
2N2926G	13p
2N2926O	12p
2N3053	22p
2N3054	73p
2N3055	65p
2N3702	11p
2N3703	11p
2N3704	11p
2N3705	11p
2N3706	11p
2N3771	210p
2N3772	195p
2N3773	280p
2N3819	24p
2N3866	97p
2N3904	11p
2N3906	12p
2N5457	42p
2N5458	42p
2N5459	43p

Signal Diodes

AA119	7p
OA47	9p
OA90	7p
OA91	7p
OA202	9p
IN4148	4p

Rectifiers

BY127	14p
IN4001	5p
IN4002	7p
IN4004	7p
IN4005	8p
IN5401	14p
IN5404	16p
WO4	31p

Zeners 400mW

3·3V-15V	12p

Regulators

7805	155p
7812	155p
7815	155p
723DIL	60p

I.C.s

741	30p
747	99p
748	50p
555	50p
556	99p
4001	26p
4011	26p
7400	15p
7402	18p
7490	62p

Switches

Slide DP	19p
Push Make	20p

All prices include VAT. P&P FREE over £2. 20p under

Name ____________________

Adress ____________________

____

Get an ACE up your sleeve!

ACE MAILTRONIX LTD
Dept. EE Tootal Street
Wakefield, W. Yorkshire WF1 5JR

P.C.B.'s and COMPONENTS for *E.E.* PROJECTS

Prices shown are for kits of on board mounted components including potentiometers but excluding hardware and transformers. Send s.a.e. for full details naming kit. All prices below include VAT. P & P 30p.

		Components Ref.	Components Kit	P.C.B
Jan	Metronome	01	1·89	65*
	Touch Switch	02	1·06	74*
	Code Scrambler	03	2·78	81*
	Rapid Diode Check	04	78	52*
Feb	Car Alarm	05	1·16	80*
	Lead Tester	06	1·26	51
	Chaser Light Display	07	8·19	1·75
	AC Meter Converter	08	1·74	60*
Mar	Audio Tester	09	8·40	(2) 1·74*
	C.R. Substitution Box	10	3·48	—
	Catch-a-light	11	2·65	82*
	Weird Sound	12	2·71	62*
Apr	Roof Rack Alarm	13	1·52	60*
	Mains Delay Switch	14	1·71	94*
	Pocket Timer	15	1·34 A	60*
May	Flashmeter	16	3·15	75*
	Mains Tester	17	·41	54*
	Teach-in Power Amplifier	18	1·55	—
	Power Pack	19	1·32	70*

* P.C.B.'s designed by TAMTRONIK to E.E. specified dimensions.

TAMTRONIK LTD. (DEPT. E.E.)
217, Toll End Road, Tipton,
West Midlands, DY4 0HW.
Telephone: 021-557 9144

Access
Buy it with Access

TRAIN AT HOME

Be an ELECTRONIC ENGINEER

Do something PRACTICAL about your future.

Firms all over Britain are crying out for qualified people. With the right training, *you* could take your pick of these jobs.

Now, the British Institute of Engineering Technology will train you in your spare time to be an Electrical Engineer.

You risk nothing! **We promise to get you through your chosen course–or, refund your fee!**

So, join the thousands who have built a new future through home study Engineering courses.

Courses in
C & G Elect. Technicians
C & G Elect. Installations
Telecomms. Technicians Exams
Television Servicing
Radio Maint. & Repairs (BIET)
Pract. Radio & Electronics
Plus over 60 other home study courses.

POST COUPON FOR FREE 44 PAGE GUIDE

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

Aldermaston Court, Dept. TEE 34 Reading RG7 4PF.

NAME (Block capitals please) ____________________

ADDRESS ____________________

____________________ POSTCODE __________

Other Subjects ____________________ AGE ______

Accredited by CACC Member of ABCC

15—240 Watts!

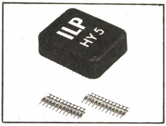
HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.

APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address

SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 4·7kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0·1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.
Price £5·22 + 65p VAT P&P free.



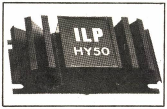
HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board. 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.

APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0·1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.
Price £5·22 + 65p VAT P&P free.



HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components

APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm
Price £6·82 + 85p VAT P&P free

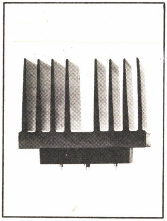
HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ

SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ±35V
SIZE 114 50 85mm
Price £15·84 + £1·27 VAT P&P free.



HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components

APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm
Price £23·32 + £1·87 VAT P&P free.

HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

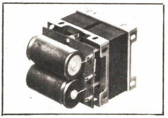
FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.

APPLICATIONS: Public address—Disco—Power slave—Industrial

SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm
Price £32·17 + £2·57 VAT P&P free.

POWER SUPPLIES

PSU36 suitable for two HY30's **£5·22** plus **65p** VAT. P/P free.
PSU50 suitable for two HY50's **£6·82** plus **85p** VAT. P/P free.
PSU70 suitable for two HY120's **£13·75** plus **£1·10** VAT. P/P free.
PSU90 suitable for one HY200 **£12·65** plus **£1·01** VAT. P/P free.
PSU180 **£23·10 + £1·85** VAT.
B1 **£0·48 + £0·06** VAT.



TWO YEARS' GUARANTEE ON ALL OUR PRODUCTS

I.L.P. ELECTRONICS LTD., CROSSLAND HOUSE, NACKINGTON, CANTERBURY, KENT, CT4 7AD.

I.L.P. ELECTRONICS LTD.,

**CROSSLAND HOUSE, NACKINGTON,
CANTERBURY, KENT, CT4 7AD.**

Please Supply ____________________
Total Purchase Price ____________________
I Enclose Cheque ☐ Postal Orders ☐ Money Order ☐
Please debit my Access account ☐ Barclaycard account ☐
Account number ____________________
Name and Address ____________________
Signature ____________________

Reg. No. 202141535

EDITOR
F. E. BENNETT

ASSISTANT EDITOR
B. W. TERRELL B.Sc.

PRODUCTION EDITOR
D. BARRINGTON

TECHNICAL SUB-EDITOR
T. J. JOHNSON G8MGS

ART EDITOR
R. PALMER

TECHNICAL ILLUSTRATORS
P. A. LOATES
D. J. GOODING

EDITORIAL OFFICES
Kings Reach Tower,
Stamford Street,
London SE1 9LS
Phone: 01-261 6873

ADVERTISEMENT MANAGER
V. PIERI
Phone: 01-261 6727

REPRESENTATIVE
N. BELLWOOD
Phone: 01-261 6727

CLASSIFIED MANAGER
C. R. BROWN
Phone: 01-261 5762

MAKE-UP AND COPY DEPARTMENT
Phone 01-261 6035

ADVERTISEMENT OFFICES
Kings Reach Tower
Stamford Street,
London SE1 9LS

Projects... Theory... and Popular Features...

There is never a dull moment in our hobby, for one never knows just what to expect next in electronics. This certainly applies to the "Games Area". Imitation or simulation of traditional parlour games has been going on for a long time. But perhaps even more interesting are the new games that owe their creation entirely to electronic circuitry. One such new creation is *Quagmire*, which we present this month. This is an excellent example of logic design applied skilfully and imaginatively in order to produce an unusual and gripping amusement for from two to four players.

Though the "end product" will undoubtedly be the main concern of constructors, detailed examination of the circuit will be rewarding for anyone wishing to learn more about logic techniques. The *Quagmire* design uses four different types of CMOS integrated circuits; these are connected up to achieve a variety of functions, such as bistable and astable multivibrators, logic gates and switches.

When these basic circuit blocks are recognised the overall circuit does not appear so formidable. Yet, though one can trace out the diagram and follow its course without too much difficulty, there does remain a nice element of unpredictability in its operation. This has been intentionally "designed in" for realism.

No such unpredictability in operation is allowed in the *Auto Nightlight* design—quite the contrary. This device should help make life a little easier for parents, since it will automatically maintain a subdued level of illumination in a child's bedroom — for example.

Other applications for this useful dusk-to-dawn light will come to mind.

Our *Short Wave Radio* will stir memories amongst some of our readers. Its front panel and chassis construction follows the traditional style of the valve era. More than that, the first stage uses a type of semiconductor that nearest resembles the thermonic triode in operation. We hope readers from both the "top" and "bottom" regions of the generation band will obtain equal pleasure from searching around the short waves. The valve may have disappeared (almost) but the fascination of S.W. Listening never diminishes.

Fred Bennett

Our August issue will be published on Friday, July 21. See page 573 for details.

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

Telephone enquiries should be limited to those requiring only a brief reply. We cannot undertake to engage in discussions on the telephone, technical or otherwise.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday
ELECTRONICS

VOL. 7 NO. 11 JULY 1978

CONSTRUCTIONAL PROJECTS

AUTO NIGHTLIGHT *A low-powered lamp that switches on at dusk and off at dawn* by A. R. Winstanley **536**

SHORT WAVE RADIO *A simple t.r.f. receiver with a tuning range from 3MHz to 16MHz* by F. G. Rayer **542**

QUAGMIRE *An exciting electronic board game combining skill and chance* by O. N. Bishop **556**

LOGIC PROBE *A pocket-sized unit for testing the logic level of TTL integrated circuits* by P. W. Bond **568**

GENERAL FEATURES

EDITORIAL **534**

PLEASE TAKE NOTE *Mains Tester, EE 100W Power Slave* **546**

SHOP TALK *New products and component buying for constructional projects* by Dave Barrington **547**

CROSSWORD No. 5 by D. P. Newton **547**

TEACH-IN 78 *Part 10. Logic circuits* by George Hylton **548**

POWER SLAVES IN ACTION! *Getting the most out of the 100W Power Slave design* by E. M. Lyndsell **553**

NO-FLASH FOR YOUR POLAROID CAMERA
A simple modification to enable indoor pictures to be taken without the aid of flash by R. H. Marco **565**

EVERYDAY NEWS *What's happening in the world of electronics* **566**

BOOK REVIEWS *A selection of recent releases* **571**

FOR YOUR ENTERTAINMENT *Hall effect, effective resistance, all charged-up* by Adrian Hope **572**

PROFESSOR ERNEST EVERSURE *The Extraordinary Experiments of.* by Anthony J. Bassett **574**

JACK PLUG AND FAMILY *Cartoon* by Doug Baker **575**

DOWN TO EARTH *Analogue or digital* by George Hylton **576**

COUNTER INTELLIGENCE *Components around the world, A speed problem* by Paul Young **579**

Back issues of EVERYDAY ELECTRONICS (June 1977 onwards—October, November, December 1977 and January 1978 NOT available) are available worldwide at a cost of 60p per copy inclusive of postage and packing. Orders and remittance should be sent to: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

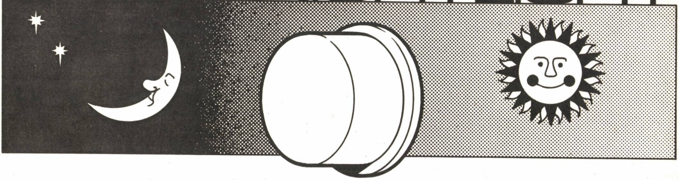
Binders for Volumes 1 to 7 (state which) are available from the above address for £2·85 inclusive of postage and packing.

© IPC Magazines Limited 1978. Copyright in all drawings, photographs and articles published in EVERYDAY ELECTRONICS is fully protected, and reproductions or imitations in whole or in part are expressly forbidden.

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot however guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

EE makes it all so EASY!

AUTO NIGHTLIGHT



By A. R. Winstanley

THIS device was designed to switch on a low-powered nightlight in a child's room. It is completely automatic so that it will switch on the lamp when darkness has reached a preset level. Although the system is quite simple, it performs very well, providing as it does a comforting glow.

The circuit employs a well-known i.c. in a popular and important configuration.

COMPARATOR

The circuit, it will be seen, consists of five "blocks", the most important one of which is the "comparator." This is the electronic brain of the system, for, having been given certain electronic information, it decides whether the nightlight should be alight or switched off. The comparator is fed by two reference voltages. One of these, V_{ref}, is fixed at half of the supply rail voltage; the other reference V_{sense} is determined by the ambient light level falling onto an electronic "eye"—in other words it is light-dependent.

The output of the comparator drives a solid-state transistor switch (for high reliability and noiseless operation) which applies power to the actual lamp.

If the reference voltage (V_{ref}) is greater than the sense voltage (V_{sense}) then the nightlight is off; similarly if the sense voltage is greater than the reference voltage then the nightlight switches on.

SAFETY FIRST

The following points are detailed separately for emphasis.

1. *It is most advisable that a metal case is used for the main unit because of R1 which gets warm during normal operation. There is a very remote chance that if a plastics case were used, it could soften or even melt if the resistor were placed close to the case. With the metal case specified in the text, the heat dissipated by R1 is totally unnoticeable and it is quite safe.*
2. *Concerning the use of an aerosol top for a lamp diffuser, it would be most unwise to use either: a smaller aerosol top than that detailed in Fig. 5 (a) or a lamp of a wattage in excess of 2·2W. Whilst the prototype lamp unit gets barely warm in use, and is therefore safe, it is possible that the polythene could soften if a smaller diffuser and/or higher power bulb was employed.*

If the text is followed carefully then no problems at all should be experienced.

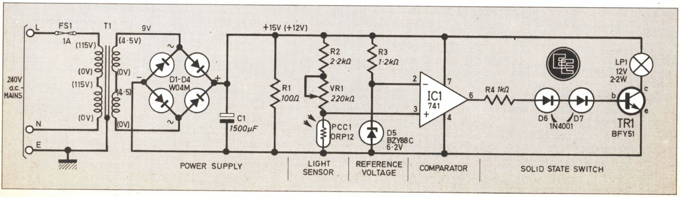
CIRCUIT DESCRIPTION

The circuit diagram of the Electronic Nightlight appears in Fig. 1. It has been divided into sections to correspond with the block diagram.

The circuit is centred around IC1, an μA741C operational amplifier integrated circuit (normally abbreviated just to "741"). This device is used in its comparator mode, for it compares two signals.

The 741 has two inputs, these being designated the inverting input (negative symbol) and non-inverting input (positive symbol). The entire principle of operation of the nightlight is this: if the voltage at the inverting input exceeds that at the non-inverting input, then the output of the IC2 is low—near zero volts. However, if the potential at the non-inverting input happens to be greater than that at

Fig. 1. Circuit of the Auto Nightlight.



the inverting input, then the output swings high, almost to the voltage of the supply rail.

If the voltages at the two inputs should be the same, then the output remains low. But it only takes a difference of a few millivolts to exist between the two inputs and the high gain of the i.c. will amplify this so much that the output will swing to either high or low (depending of course on its previous state) in a very short time.

The inverting input in this design is permanently clamped to a potential of 6·2V (±5 per cent) by means of a Zener diode D5 and its associate current-limiting resistor R3. The current flowing through the Zener is 5mA and so it dissipates 30mW.

The voltage at the other input, however, depends on the level of light being received by PCC1, an ORP12 light-dependent resistor—the "electric eye" of the system.

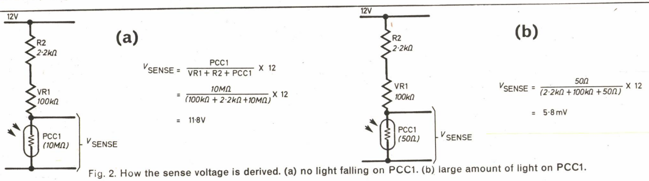

12V
R2
2·2kΩ
VR1
100kΩ
PCC1
(10MΩ)
V_{SENSE}
(a)
$V_{SENSE} = \frac{PCC1}{VR1 + R2 + PCC1} \times 12$
$= \frac{10M\Omega}{(100k\Omega + 2{\cdot}2k\Omega + 10M\Omega)} \times 12$
$= 11{\cdot}8V$
12V
R2
2·2kΩ
VR1
100kΩ
PCC1
(50Ω)
V_{SENSE}
(b)
$V_{SENSE} = \frac{50\Omega}{(2{\cdot}2k\Omega + 100k\Omega + 50\Omega)} \times 12$
$= 5{\cdot}8mV$

Fig. 2. How the sense voltage is derived. (a) no light falling on PCC1. (b) large amount of light on PCC1.

POTENTIAL DIVIDER

R2, VR1 and PCC1 form a potential divider, they split up the supply rail into a series of lesser voltages. It can, to make things easier, be assumed that VR1 is set to halfway, and can therefore be replaced by a fixed resistor of about 100 kilohms.

Fig. 2 shows how the sense voltage (i.e. the voltage at the non-inverting input) varies by potential divider action as the light level changes.

In Fig. 2a there is no light falling on the l.d.r. and so its resistance is in the order of 10 megohms. Therefore, because the supply rail is at 12V, the output of the potential divider is about 11V, as the calculation in the diagram shows.

Similarly, in Fig. 2b a large amount of light is falling on the l.d.r. and so its resistance is about 50 ohms, giving an output of about 6mV.

Hence when it is light, the voltage at the inverting input is 6·2V but the non-inverting input is at less than 10mV—therefore the output of IC1 is low and the lamp is off (but see later).

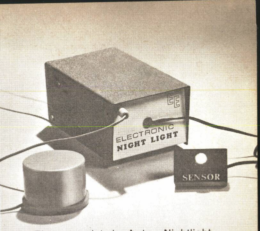
When the ambient light level falls, the resistance of the l.d.r. increases so that the potential at the non-inverting input eventually equals and then exceeds the 6·2V reference voltage at the inverting input, so that the output of IC1 swings high.

Because the resistance of the l.d.r. changes very slowly in this application, the output of IC1 does not rapidly switch from low to high, in practise it takes from about 30 seconds to one minute for the lamp to reach full brightness.

TRANSISTOR SWITCH

The output of IC1 drives a simple medium power transistor switch (TR1) which allows current to flow through LP1, which is the lamp forming the nightlight. The lamp is rated at 12V 0·18A, and so has a low power of about 2·2W. This may seem to be insufficient but proves to be, if anything, a little too bright for some rooms.

The transistor switch design is very flexible, and so the lamp may be replaced by a 12V 0·1A type without modification. If on the other hand the lamp is not bright enough, then a second 12V 0·18A lamp may be added directly in parallel with LP1, again without modification. (No harm will result from drawing too much current from the i.c. because the output of IC1 is short-circuit proof, and current-limits at about 20mA.



The completed Auto Nightlight showing the control unit, sensor and light housing.

Unfortunately, when the output is described as "low" it is not quite at zero volts—in fact it still has a potential of over one volt. This would be enough to switch on the transistor, as only 0·65V is required to turn the transistor hard on, illuminating the lamp. Indeed, in practise the lamp would remain on all the time!

To overcome this problem, two silicon diodes D6 and D7 have been included in the circuit. When they are carrying current, the diodes each drop 0·6V across themselves; so that together they will drop about 1·2 volts, and so removing any drive to the transistor when IC1 output is "low".

POWER SUPPLY

The circuit operates from a 12V d.c. rail, and draws a maximum of 200 mA. Therefore battery operation is really out of the question, and so the rail is derived from a mains power supply.

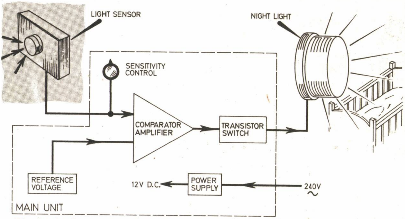
Mains voltage is "stepped down" by T1, the secondary of which is wired to give 9V a.c. at 670mA. This alternating voltage is rectified by D1-D4 to give a d.c. voltage which contains a very high a.c. ripple content. This is smoothed out by the electrolytic capacitor C1 to give an unregulated voltage of some 16-17V d.c. when the lamp is off. This comes quite close to the maximum operating voltage of the integrated circuit, and though it is very unlikely that this rating would be exceeded, R1 has been placed directly across the power supply to increase the quiescent (or "tickover") current drawn by the circuit.

This has the effect of pulling down the voltage rail because it is unregulated, and in fact it is reduced to 15V when the lamp is off and comes down even further to 12V when the lamp is illuminated. R1 dissipates $(15^2/100)=2{\cdot}25$W; therefore a power resistor is called for here, and not the usual half-watt device.

As a matter of interest, the only other satisfactory method of providing a more stable power supply voltage would be to regulate it using either a high power Zener diode (which would be difficult to obtain) or to use one of the modern regulator i.c.s. now available, which is rather like using a sophisticated sledgehammer to crack a small nut. The use of the power resistor as shown gives good enough results for about 15p!

The rectifier D1-4 can either be four separate diodes (actually rectifiers), or a device called a "bridge rectifier" in which four rectifiers are encapsulated into one small package. The latter is more convenient to use, but is twice as expensive as four separate rectifiers.

HOW IT WORKS



The Light Sensor is a light-dependent resistor (l.d.r.). Together with the Sensitivity Control VR1 it forms a potential divider across the 12V supply. Voltage is tapped off this divider and applied to one input of the Comparator Amplifier.

When exposed to ambient light, e.g. in the day time, the resistance of the l.d.r. is low, but when no light falls upon this device its resistance becomes very high. Thus the voltage applied to the Comparator varies conversely with the amount of illumination received by the Sensor.

A fixed Reference Voltage is applied to the other input of the Comparator. The Comparator compares these two signals. If the Sense Voltage is in excess of the Reference Voltage, the output of the Comparator swings high, drives the transistor TR1 on and so completes the circuit for the low voltage Nightlight lamp LP1.

Conversely, when the Sense Voltage falls below the Reference Voltage the Comparator output is low and the lamp is switched off.

The Light Sensor must be sited so that it is not illuminated by the Nightlight which it controls, but is subject only to the natural light conditions. Thus the Sensor and the Main Unit could be installed on the landing adjacent to the child's bedroom in which the Nightlight is located.

START HERE FOR CONSTRUCTION

CIRCUIT BOARD

The main unit is built in an R.S. Type 11 instrument case. The lamp and photocell are connected by flying leads to the main unit.

Construction may commence with the component panel (see Fig. 3) which is 0·1in matrix stripboard size 24 strips by 36 holes. Start by drilling a $\frac{5}{16}$in hole in each corner to take a 4BA self-tapping screw. Make all of the breaks in the copper strip using either the proper spot face cutter or a hand held twist drill.

SOLDERING

Insert all of the solder pins (9 in all) and then solder the i.c. socket into place. The six strip-interconnection wires may now be soldered in: they consist of solid "bus wire" which should be insulated with 1mm p.v.c. sleeving where there is a danger of them touching other component leads.

Proceed to solder in all of the components. Particularly ensure that C1, D5 and the bridge rectifier are connected the right way round. An error here could have dramatic results.

The transistor, bridge rectifier, Zener diode and i.c. output diodes are of course semiconductors, and as such should not be heated for more than about four seconds when soldering them.

For those who are inexperienced in soldering semiconductors, it is advised that a special heatshunt which is available is used. This is clipped onto the wires being soldered, and serves to dissipate any excess heat, thus preventing damage occuring to the device.

TR1 should be soldered in last of all. It is fitted with a small "crinkled" TO-5 heatsink, and this should be fixed on *before* the transistor is soldered in. When this is in position the small identification tag on the case of the transistor will not be easily visible, therefore pay particular attention to see that the device is inserted the correct way round before fitting the heatsink.

R1 is not mounted flush to the board in the usual way. It dissipates a fair amount of heat, and so the resistor body is allowed to overhang the stripboard where it can

AUTO NIGHTLIGHT

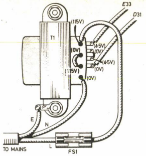


Fig. 4. Mains transformer T1 wiring details.

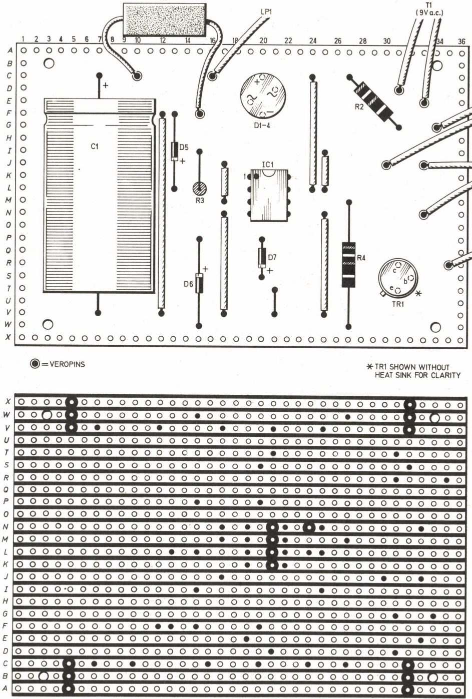


Fig. 3. The component board. Breaks in the copper strips must be made before components are mounted on the other (plain) side of the 0.1 in matrix stripboard. Note that the TR1 heatsink must be fitted before this component is soldered in position.

radiate its heat without affecting nearby components. It will be seen that the slightly longer leadout of the resistor needs to be insulated with p.v.c. sleeving to prevent it shorting to a nearby solderpin.

Having completed the circuit board, now inspect (preferably with a magnifying glass) each of the soldered joints, looking out for "dry" connections or whiskers of solder bridging adjacent copper strips. The underside of the stripboard could be sprayed with printed circuit lacquer if this is available. Finally insert the i.c. into its socket, again making certain that it is put in the right way round—incorrect polarity will destroy it.

MECHANICAL DETAILS

The next part to be tackled is the metalwork. The chassis has to be drilled to take T1, the fuse, VR1, the circuit board, the mains cable entry (fit with a grommet) and the cable entries for LP1 and PCC1. Four holes are also needed in the base to take a set of plastic cabinet feet.

On the prototype, LP1 was connected to the main unit using a 2·5mm jack plug and socket, whilst PCC1 was taken straight through to the circuit board. The constructor should choose which method will be best: either use a connector or solder the interconnecting wires straight to the component panel.

The circuit board is fixed to the chassis using special P.C. pillars see photo) which are simply secured using 4BA self-tapping screws. The pillars are very easy and convenient to use, and save tiresome and frustrating fiddling with nuts, bolts and spacers.

The case may be lettered with W. H. Smith's "Magic Letters" and sprayed with protective lacquer. Of course, all of this is best done before any items are bolted to the case.

COMPONENTS

Resistors

R1	100Ω 4W	
R2	2·2kΩ	½W ± 5%
R3	1·2kΩ	
R4	1kΩ	

Potentiometer

VRI	220kΩ linear

Capacitors

C1	1500μF 25V elect. (axial leads)

Semiconductors

PCC1	ORP12 l.d.r.
IC1	741 8-pin d.i.l.
D1-4	1A 50V bridge rectifier (W04M)
D5	6·2V 400mW Zener. BZY88C6V2
D6, 7	IN4001 (2 off)
TR1	BFY51 silicon *npn*

Miscellaneous

T1	Mains transformer: Sec. 0–4·5V + 0–4·5V, 0·67A (Doram 66–110–4)
FS1	1A 20mm fuse with chassis holder
LP1	12V 2·2W M.E.S. lamp, and batten holder

Stripboard: 0·1 matrix, 24 strips × 36 holes; metal case type 11 (Doram 68–140–7); 8-pin d.i.l. socket; P.C. pillars (4 off—Doram 69–611–7); TO–5 push-on heatsink; 4BA self-tapping screws (8 off); knob; cabinet feet (4 off); mains input cable (6A 250V); lightweight inter-connecting, cable; solder; solder pins. 2·5mm plugs and sockets (2 off)—optional see text.

Materials for sensor and nightlight assemblies.

See
Shop Talk
page 547

FOR GUIDANCE ONLY

ESTIMATED COST OF COMPONENTS
£8.00
excluding case

NIGHTLIGHT CONSTRUCTION

The prototype nightlight is illustrated in Fig. 5(a). It is very easy to make but is very effective. The M.E.S. batten holder is mounted on a thin plywood base, which is of dimensions to make it a snap-fit into the base of a large polythene aerosol top.

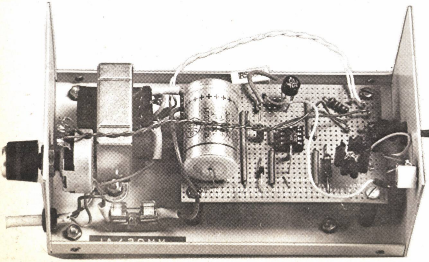
A small hole is made in the aerosol top to take the cable inlet for the lampholder. Twin-core cable is then taken from the terminals of the lampholder to the main unit. Cable length may be in excess of 10 metres, but about 4-5 metres should generally suffice.

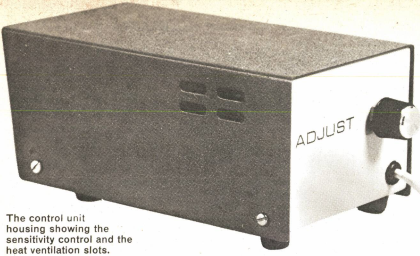
It will be found that the aerosol top idea works most effectively if a warm colour such as red or orange is chosen.

SENSOR CONSTRUCTION

The prototype light sensor consisted of a small plastic box (which was actually from an old stylus package) onto which the ORP12 light dependent resistor was mounted (see Fig. 5(b)). The l.d.r.

Layout of the components for the control unit. Note the position of the mains transformer, the heatsink for TR1 and the sleeving on resistor R1.





The control unit housing showing the sensitivity control and the heat ventilation slots.

was fixed to the top using a proprietary adhesive; two very small holes 9·5mm apart were drilled to take the photocell leadouts.

Twin-core flex was then soldered to the leadouts and then taken to the main unit where it passed through a hole in the case and was soldered directly to the stripboard.

Cable length should be kept as short as possible, although it can be up to about 5 metres.

Another idea possibly for sensor construction might be to use a white aerosol top as a diffuser with the ORP12 mounted inside, in a fashion similar to the nightlight.

COMPLETION OF WIRING

The rest of the wiring should now be completed to conform with Fig. 3. All joints which are at mains voltage should be of a good quality; they should not be dull or crystalline. Ensure that the windings of the mains transformer are connected together correctly (see Fig. 4). Finally, the earth wire of the mains input cable is soldered to a 4BA solder tag which is fixed underneath one of the transformer mounting bolts.

Check all of the wiring carefully and then plug in the nightlight and photocell if connectors are used. Set VR1 (the "sensitivity" control) to approximately its midway position and then plug in and switch on. The wirewound resistor R1 should start to get warm.

The nightlight may or may not illuminate, but if it is not alight then covering the photocell completely with, say, a small cardboard box should cause the nightlight to switch on. Now, removing the cover should result in the light going out. (This assumes of course that the initial testing is carried out in daylight!) (The unit is now complete.

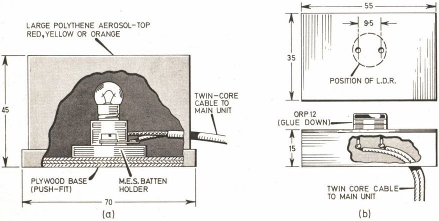
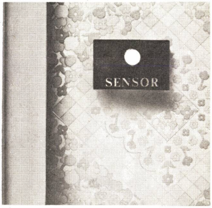

LARGE POLYTHENE AEROSOL-TOP RED,YELLOW OR ORANGE
45
TWIN-CORE CABLE TO MAIN UNIT
PLYWOOD BASE (PUSH-FIT)
M.E.S. BATTEN HOLDER
70
(a)
55
9·5
35
POSITION OF L.D.R.
ORP 12 (GLUE DOWN)
15
TWIN CORE CABLE TO MAIN UNIT
(b)

Fig. 5. Construction of the lamp unit (a) and the light sensor unit (b).

The light mounted in a convenient position on a wall.



The sensor unit mounted in a convenient position in a room to monitor the ambient light.

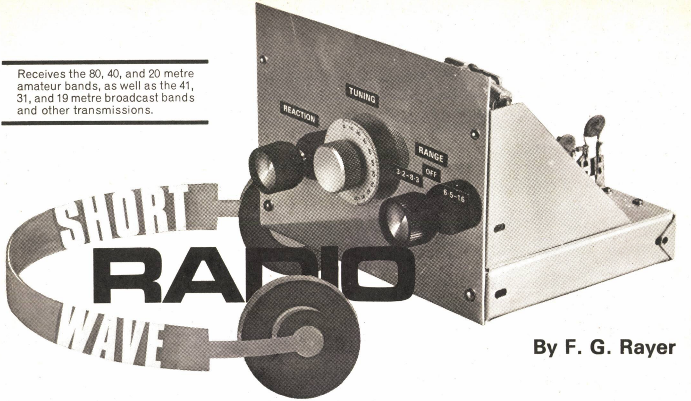
FINAL SITING

The system can now be installed in the room where it is to be used. It may take some experimenting with the position of the photocell to achieve the best results: initially the lamp might be coming on far too early, in which case reposition the ORP12 unit in a place where it receives more light. Alternatively adjust the sensitivity control to give the desired switching point. Light from the lamp should not be allowed to fall back onto the photocell.

Each set-up is bound to be different and so it is not really possible to generalise on the sensor position or sensitivity control adjustment which would give the desired operation of the unit. It is a case of "reposition and try again"—but the results should justify the trouble, because there is now one chore less to do last thing at night. Electronics does it for you. ⌑

Receives the 80, 40, and 20 metre amateur bands, as well as the 41, 31, and 19 metre broadcast bands and other transmissions.

SHORT WAVE RADIO



By F. G. Rayer

IN THE earlier days of radio, one valve and two valve receivers were popular with home constructors. They were capable of worldwide reception, due to the high sensitivity obtained by *reaction*.

A well-known supplier of those days advertised that it was possible to receive Australia with a one valve receiver. In the writer's experience this was so, though it meant early-morning listening on the 25 and 31 metre bands, with signals *just* readable on phones in the absence of interference.

Such results depended wholly on the correct use of reaction (or regenerative feedback), and the present-day field effect transistor is almost identical in performance with the earlier valve in this respect.

The present design uses the MPF102 type f.e.t. as regenerative detector, followed by a BC108 silicon transistor as audio amplifier. It covers from approximately 3·2MHz to 16MHz, or about 95 to 21 metres, having two coils selected by a switch. This coverage includes many interesting frequencies, as well as the popular 3·5 to 3·8MHz amateur band. The receiver can resolve c.w. (morse) and s.s.b. (single-sideband) signals, as well as ordinary a.m. (amplitude modulated) transmissions.

CIRCUIT DESCRIPTION

In Fig. 1, section b of the range switch S1, selects either L2, or L4, tuned by C3. Aerial coupling is by the small trimmer capacitor C1, with input to TR1 gate. The drain is taken by switch S1a to the feedback windings of the coils L1 and L3. Capacitor C2 controls the amount of feedback or regeneration. Audio signals pass through the radio frequency choke, to reach C6 and the audio amplifier TR2, which considerably boosts the volume. Switch S1c, provides on/off switching of the receiver.

START HERE FOR CONSTRUCTION

TAG STRIP

The smaller components are wired directly to a tag strip, as shown in Fig. 2. This is later fixed to the chassis by the tags marked MC, which provide the negative or earth return. Components are kept quite close to the strip and somewhat above the tags, so that they will be clear of the tuning capacitor and adjacent coils.

The transistors should be soldered on last, leads being identified from Fig. 2.

CHASSIS AND PANEL

The chassis is 127 x 178mm and 25mm deep constructed from "Universal Chassis" parts. When using the Universal Chassis parts it is necessary to have the shorter runners inside the longer runners.

Two brackets are formed by cutting a 100 x 100mm flanged universal chassis side diagonally and clipping corners off to reduce the height to about 83mm. A rigid assembly is necessary, so a 178 x 25mm runner is also present behind the panel. All these parts are fixed together with nuts and bolts, or self-tapping screws. It is as well to punch or drill holes for the EARTH, AERIAL, and PHONES terminal strips before fitting the back runner. These, except EARTH, must of course clear the metal.

FRONT PANEL DRILLING

The drilling details for the front panel are shown in Fig. 3. The actual layout is not too critical, although the same basic design should be followed.

The size of the larger holes depends on the size of the individual components as such no sizes have been given. The hole for C3 is more likely to be changed in the vertical direction. That is, it can either be moved up or down as required, depending how the capacitor is mounted. The horizontal position is correct as being in the centre.

Fit the variable capacitor and slow-motion drive as in Fig. 2, a hole about 20mm in diameter being necessary for the latter.

MOUNTING BRACKETS

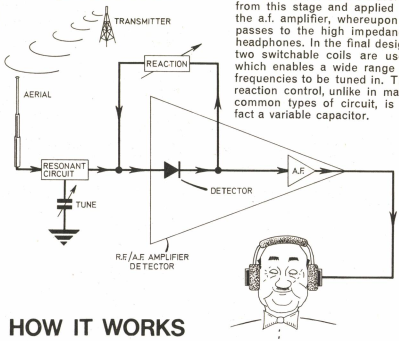
Three small metal brackets mount the large capacitor C3 and these can be cut from a spare universal chassis side if necessary. Line up the slow-motion drive and capacitor correctly before tightening the fixing bolts.

The regeneration capacitor, C2, is a standard compression trimmer, with a 7mm extension spindle fitted with a control knob. It fits on a bracket as in Fig. 2, with the spindle projecting through a clearance hole in the panel. Dimensions of this bracket is shown in Fig. 4.

HOW IT WORKS

Radio frequency signals induced into the aerial are coupled to the **RESONANT CIRCUIT**. This circuit is tuned by a variable capacitor to select the required station. The **DETECTOR** stage consists of a field effect transistor and associated circuit which supplies feedback via the reaction control, back to the input of this stage. Thus a loop consisting of r.f. and audio is generated in the f.e.t.

The audio is now recovered from this stage and applied to the a.f. amplifier, whereupon it passes to the high impedance headphones. In the final design two switchable coils are used which enables a wide range of frequencies to be tuned in. The reaction control, unlike in many common types of circuit, is in fact a variable capacitor.



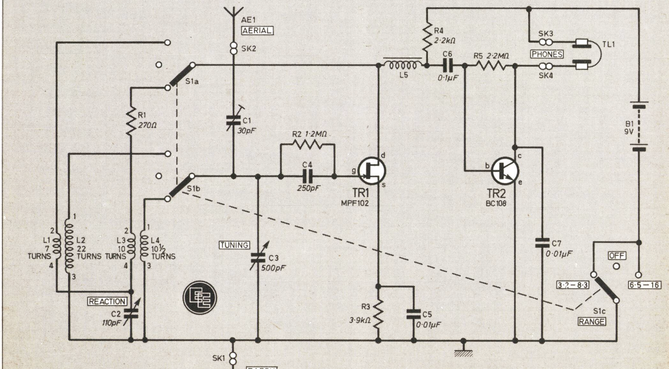


Fig. 1. Circuit diagram of the Short Wave Radio.

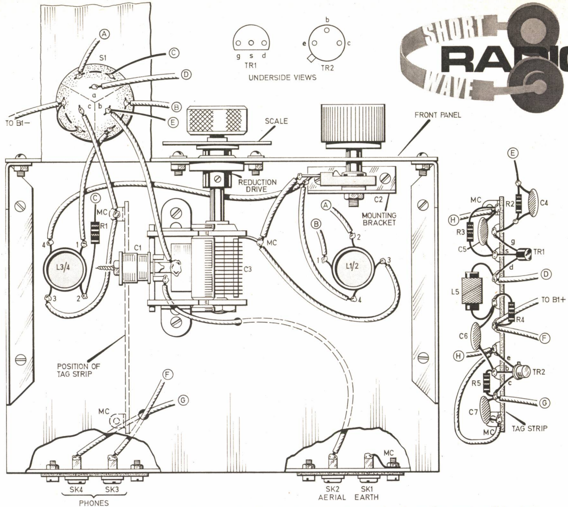


Fig. 2. Complete wiring for the radio. Note that for clarity the front panel has been "opened out" to show the connections to S1. The position of the tag strip is shown dotted, the wiring of which is shown to the right. MC denotes a connection to the chassis.

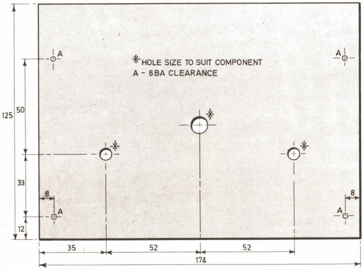


Fig. 3. Drilling arrangement for the front panel. The position of the centre hole (for C3) depends on the actual component used, hence no vertical measurement has been given.

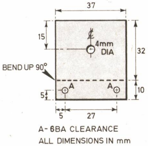


Fig. 4. Bracket required for mounting C2. Material used in the prototype was 18 s.w.g. aluminium.

COMPONENTS

Resistors

R1	270Ω
R2	1·2MΩ
R3	3·9kΩ
R4	2·2kΩ
R5	2·2MΩ

All ¼W carbon ± 5%

Capacitors

C1	30pF beehive trimmer
C2	110pF compression trimmer
C3	500pF single-gang variable
C4	250pF disc ceramic
C5	0·01μF disc ceramic
C6	0·1μF disc ceramic
C7	0·01μF disc ceramic

Semiconductors

TR1	MPF102 *n*–channel field effect transistor
TR2	BC108 silicon *npn*

Inductors

L1, 2, 3, 4	wound as described (see text)
L5	5mH radio frequency choke

Miscellaneous

S1	3-pole 3-way rotary switch
SK1, 2, 3, 4	twin-screw terminal strips (2 off)
TL1	high impedance headphones
B1	9V battery PP6, PP3 etc.

Universal chassis 178 × 125 × 25mm; one extra flat plate for front panel 175 × 125mm; extra flanged side 100 × 100mm; ten-way tag strip with two tags earthed; extension spindle for C2 (Home Radio); aluminium for bracket; battery connector to suit B1; three large control knobs, one with fitted scale for C3; 24 and 34 s.w.g. enamelled copper wire; material for coils; Bostik or similar clear glue; sleeving; 3:1 reduction drive for C3; connecting wire.

See **Shop Talk** page 547

FOR GUIDANCE ONLY

ESTIMATED COST OF COMPONENTS

£5·50

excluding case and headphones

WIRING

Screw the tag strip in position as indicated in Fig. 2 and fix the coils by using screws from below.

The rotary switch is fixed to the panel by its bush nut, and is shown out of place in Fig. 2 so that connections to it can be seen more clearly.

Connect C2 so that the top tag or plate near the panel goes to chassis.

When fitting C3, solder a lead to its bottom tag, to go to switch S1a. Trimmer C1 is soldered to the top tag. A wire runs from the second tag of C1 through the chassis, to the AERIAL connecting point.

Adding the PHONE and battery connections finishes the wiring. A PP3, PP4 or PP6 9 volt battery is suitable, and the correct snap fasteners or battery connector should be used as battery polarity must always be as shown.

INDUCTORS

Both sets of coils are wound on insulated formers 16mm in diameter and 45mm long. Paxolin tube of the correct size can be used or tubes can be made from rolled up thin card.

For the latter, cut strips about 45mm wide and several centimetres long. Wind the card on any convenient object, such as a wooden dowel, say about 12mm in diameter. Wind a few layers until the outside diameter reaches 16mm, and then remove the dowel.

Winding details for the coils are shown in Fig. 5. First start with L2, drill or pierce a hole at point one about 3mm from the top, leave a space of about 22mm and make two holes at point three. Pass a length of 24 s.w.g. wire through the top hole and wind 22 turns slightly spaced. Now pass it through hole three.

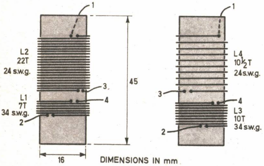
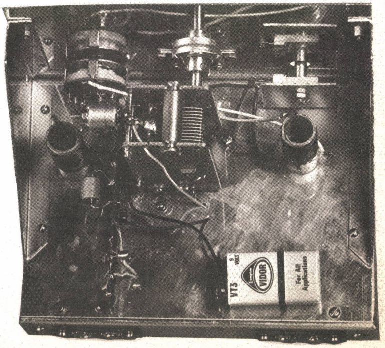
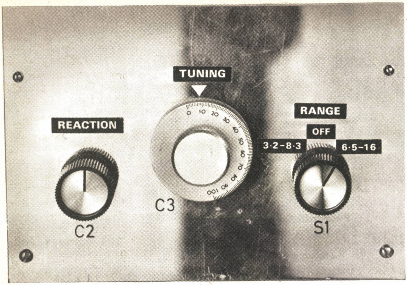


Fig. 5. Winding details for the two sets of coils. The completed coils are mounted on the chassis using small sections from a wooden dowel forced into the base of each coil and glued. The coil is then mounted vertically on the chassis using short wood screws.

Rear of the Shortwave Radio showing position of the component tag strip, the two coil formers and tuning capacitors. Note the beehive capacitor C1 mounted on C3.





Front panel layout for the Shortwave Radio showing the reaction and tuning controls and the range selector switch.

For L1 start by threading it through hole four, leaving about 3mm space between L2. Wind on seven turns side by side, finish by anchoring the wire at point two.

Coils L3 and L4 are wound in a similar fashion, only this time 10½ turns are required for L4, occupying the same space, and 10 turns for L3. The ends may be left long to reach the various parts of the circuit or can be extended using insulated wire.

If available the Wearite PO5 coil can be used for L1/L2 and the PO3 coil for L3/L4, without any changes in the circuit.

AERIAL EARTH AND HEADPHONES

Though signals can be received with an indoor aerial and no earth, an outdoor aerial is naturally better, and would be considered almost essential. It can generally be about 7·5 metres to 15 metres in length, and should be as high and clear of earthed objects such as house walls as can be arranged.

An earth is generally worth while, and can help to avoid hand-capacity effects by grounding the metal panel and chassis. The earth lead can run to a metal spike driven into the ground.

The circuit is intended for high impedance headphones. Typical phones have resistances of 600 ohms, and 2 kilohms impedance. Naturally other phones can be used, but low impedance or crystal earpieces should not be used.

REGENERATION

It is upon satisfactory regeneration that results mostly depend. Where a receiver of this type is found disappointing, this almost always arises from not using regeneration correctly. Its adjustment is quite critical, and has to be varied while tuning.

Initially, set C1 about one-third closed, and unscrew C2. As C2 is screwed down to increase capacity, a point should be found where signals are heard when tuning. Closing C2 further will increase volume, until a point is reached where a whistle is heard when tuning to one side or the other of a transmission. For a.m. reception, sensitivity is at a maximum if regeneration is set so that this whistle *just* fails to arise.

Regeneration has to be adjusted in conjunction with tuning, because the setting for C2 changes as tuning progresses across the band.

The degree of aerial loading influences regeneration. This means that if regeneration is not obtained on some frequencies, then C1 must be unscrewed a little. But having C1 unscrewed unnecessarily will also weaken the signals. This is why C1 is placed within easy reach. Resistor R1 is included for the higher frequency band because it was found that regeneration tended to be too strong here.

Coils L1/L2 tune approximately 3·2 to 8·3MHz, and L2/L3 approximately 6·5 to 16MHz, the low frequency end of this band below about 8·3MHz not being used.

To receive c.w. or s.s.b. signals, regeneration has to be advanced a little beyond the best point for a.m. This is perhaps best tried at first in the 80 metre band, which will be found using L1/L2 with C1 nearly fully closed.

The propagation of short wave signals depends on the time of day and other factors, but a few periods of listening (preferably at different hours) will show what to expect.

PLEASE TAKE NOTE

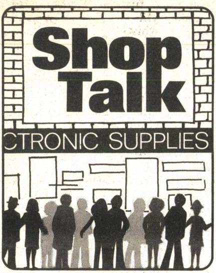
MAINS TESTER *(May 1978)*
We regret that two lines of copy under the heading of USING THE UNIT were not set and missed out of the article. The correct setting for this section should read as follows:

USING THE UNIT
When the unit is plugged into a correctly wired mains outlet socket, the outer two neons should light, LP1 and LP3. If all neons light, the "earth is disconnected. If two adjacent neons light the" live and neutral connections to the socket have been transposed. If the ...

EE 100W POWER SLAVE *(June 1978)*
One of the starred items on the heading page should read "4 and 8 ohm Speaker Systems" and not as shown.

In the specification box the Power Bandwidth should read 100 watts r.m.s. ± 0·5dB from 20Hz to 20kHz. In both cases under Total Harmonic and Intermodulation Distortion the figure of 100mV should read 100mW.

The type numbers for the mains transformers were incorrectly quoted and should be ammended to read type 1190 (4 ohm version) and 1191 (8 ohm version). The type number is correct on the circuit diagram, Fig. 1a.



By Dave Barrington

Master Tapes

Three new Scotch cassette tapes just introduced by 3M United Kingdom Ltd., should satisfy most tape enthusiasts needs.

Simplicity of choice for the user is the theme of the "Master" series of cassette tapes which come in three grades; standard or ferric oxide, chrome and ferrichrome. This coincides with the tape switch position on many machines and each cassette housing and tape cartridge is clearly marked with its grade.

The Master 1 tape will give best results on the normal bias, 120μS, switch position or on decks with a pre-set bias. It consists of premium grade low-noise ferric oxide and is claimed to give excellent low, middle and high frequency response. They also claim a 4dB better maximum output than ordinary low-noise cassettes.

The Master 2 is for Chrome bias, 70μS, position and is a high output low-noise tape formulated from modified ferric oxide encapsulated with cobalt. It is claimed that this gives 3dB better signal-to-noise ratio and 3dB better sensitivity at low and high frequencies than normal chromium dioxide tape.

With a patented dual-layer construction, the Master 3 tape (for FeCr switch position) is claimed to increase both low and high frequency sensitivity over chromium dioxide and ferric oxide tapes. Providing a 3dB increase in maximum output at low frequencies and 2dB at high frequencies over chrome cassettes.

Listening to a demonstration, in which a live performance was switched to tape, it was very difficult to tell when the artist and pianist were miming and when they were performing live.

Constructional Projects

The only components likely to cause trouble when constructing the *Shortwave Radio* are the tuning, "beehive" and compression capacitors C1 to 3. These can be obtained from Home Radio who are also able to supply all the hardware for this project.

All components for both the *Logic Probe* and the *Quagmire* game are easily obtainable from our advertisers and should not cause any problems.

Regarding the *Auto Nightlight* the mains transformer T1 specified for this article has twin primary and secondary windings. The two primary windings are wired in series and the two secondary windings are wired in series to give the required output voltage.

There is no reason why a transformer with a primary winding rated at 230/240 volts and a secondary winding of 9 volts should not be used, provided it is rated at approximately 700mA to 1A.

Apart from the above mentioned items all other components for the *Auto Nightlight* should be readily available.

CROSSWORD No 5

BY D.P.NEWTON

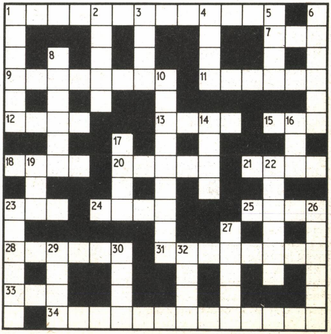
ACROSS

1 A pair of hi fi demons. (3,3,7)
7 They say this is only human.
9 Heated, we can expect emission.
11 Without it we are powerless.
12 The price per unit.
13 An aerial display.
15 A useless component.
18 How low can transistors get?
20 An edible charge carrier?
21 A blown fuse puts the circuit in this state.
23 Shown the way it glows profusely.
24 The power to get steamed up?
25 Not a gallop.
28 A glassy crystal of some electronic use.
31 Although often musical, it can reproduce most sounds.
33 Snow in a device.
34 Without this control, a TV might well present problems. (9,4)

DOWN

1 A loudspeaking pet?
2 Social averages.
3 A non-flowering plant.
4 The forerunner of 31 across.
5 Behind.
6 Worn and somewhat tatty.
8 Electronic crockery?
10 Silicon controlled rectifier.
14 CRT's must stick to them.
16 Employ.
17 A caustic additive which gives a lift.
19 Calling card for an expert pilot?
22 To display in regular array.
23 A crystal of controlled transparency.
26 Switch into action. (4,2)
27 Pertains to sound.
29 Two-dimensional space.
30 Black.
32 Solar rising point.

Solution on page 577



TEACH-IN 78

Part 10

BY GEORGE HYLTON

LOGIC—GATES AND CIRCUITS

THIS month we introduce an important new subject: logic.

The subject reflects the ever-advancing technology of our times, computers, microprocessors, integrated circuits etc. All are now part of our everyday life, and although the significance is not too apparent to most people, those of you who are studying electronics are, inevitably, going to come face to face with logic circuits, sooner or later.

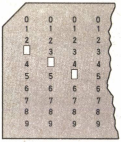


Fig. 10.1. Part of a punched card, showing the holes to register the number 345.

PUNCHED CARDS

Punched cards have been used for many years to store information. The principle is very simple. It is rather like those multiple-choice examination papers which are so popular nowadays.

The card has lots of numbers printed on it. To select one, a hole is punched through it. If, for example, a card has the numbers 0 to 9 in columns, Fig. 10.1, and you want to register the number 345, the appropriate digits in the first three columns would be punched through as shown.

To read the card, the first column on the left is read, then the second, and so on.

Punched cards can be sorted by machines. If for example, a school medical clinic kept records of vaccination on punched cards, and 345 meant that a a pupil *had* received a dose of polio vaccine, the machine might be set to sort out the cards of those who had *not* had a dose.

Coding systems like this which have only *two* possible states of existence, hole or no hole, dot or dash, black or white, etc, are called **binary codes.** They really consist of ways of recording the answers to strings of questions, but questions only capable of two answers, yes or no. Looked at this way, the "0" position in column one answers the question "Is the first figure 0?". The "1" position answers the question "Is it a 1?" and so on down the column.

CODES

The idea of coding in this yes/no fashion is very old. In fact it was used as a cipher for transmitting secret messages by Shakespeare's contemporary Sir Francis Bacon. In his book "The Advancement of Learning", Bacon shows how, in principle, his code can be used to conceal any secret message in any clear message, provided that the clear message is five times as long as the secret one.

He gives as an example the clear message "Stay till I come to you", which conceals the secret message "Fly".

How is it done? Forget that the letters of the clear message are ordinary letters. Think of each one as being either A or B. If it is written a tiny bit above the line it is an A. If below the line, it is a B. A 15 letter message now turns into a string of As and Bs, such as: AABABABABABABBA. This is divided into groups of five; AABAB ABABA BABBA.

To decode, you use a system where each letter of the alphabet is coded into five A and B combinations, starting with AAAAA for the letter A, AAAAB for B, AAABB for C, and so on.

Coming back to punched cards again it is of course possible to read them electrically. For example, it would be possible to have spring contacts on each side of the card, so that the contacts would be made where there was a hole and not made when there was no hole.

To select cards with particular information punched into them you would arrange for the sorting machine to throw out only cards which allowed the right combinations of contacts to make.

LOGIC GATES

Suppose, for example, there are a large number of candidates for the job of a salesman in an electronic component shop. A card could be made for each one. All the appropriate qualifications would be "punched in"—age, sex, experience, previous salary, etc. . . . So when the boss said: "What I want is a 25 year old unmarried man with two years shop experience and a current driving licence", the machine could be set so that when the appropriate string of contacts were all closed, Fig. 10.2, the battery would be connected to energise the card selection mechanism.

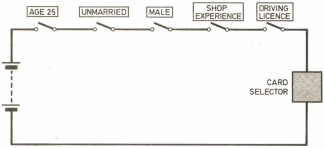


Fig. 10.2. Switch contacts are arranged as shown to select a candidate with all the necessary qualifications. This arrangement represents the AND function.

If the boss had said: "I'll accept a man who either has two years shop experience, or who is a licensed radio amateur", how could the option experience *or* radio "ham" be translated into contact form? The word **or** suggests that *either* of two possible paths for current is permissible. So to indicate **or**, parallel contacts are needed, Fig. 10.3. More than two could be used if there were a number of acceptable alternatives.

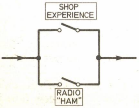


Fig. 10.3. In this arrangement the switches select a candidate who has either of two alternatives. This represents the OR function.

Evidently the contacts or their equivalents are carrying out a selection programme. They are an example of **logic.**

The contact chains contain two basic requirements of binary logic. One of these is the ability to pass on a signal when a number of crucial questions must *all* be answered yes: for example, under 25 (yes) AND unmarried (yes) AND with two years shop experience . . . and so on.

Unless the answer to all the questions is yes there is no onward path for the signal.

The other, of course, is the case where there are alternatives; shop experience OR licensed amateur etc. In electronic logic, the circuits which do the equivalent job of contacts are called **gates.** Two important kinds are the AND gate and the OR gate.

A possible form of AND gate uses three transistors in series, Fig. 10.4. Only when TR1, TR2, *and* TR3 are *all* turned on does any current pass through R4 to turn on TR4 and provide an output. The transistors are turned on by positive signals at A, B, and C. So this is a 3 input AND gate.

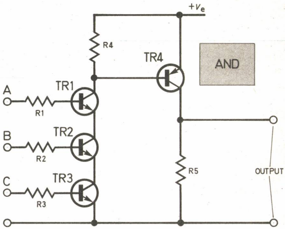


Fig. 10.4. An example of an AND gate. An output is only given when the inputs A *and* B *and* C are positive.

A possible OR gate has three transistors in parallel, Fig. 10.5. Turning on *any* one of TR1 *or* TR2 *or* TR3 causes current to pass through R4 and so produces an output. So this is a 3 input OR gate.

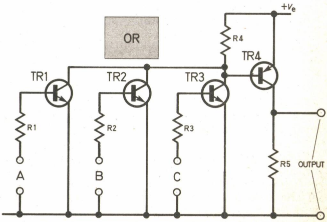


Fig. 10.5. An OR gate. An output results when the inputs A *or* B *or* C go positive.

Note that in both circuits the function of transistor TR4 is to transform a negative voltage, from R4 into a positive voltage, across R5. So TR4 is not really part of the logic. It is just an inverter. Without it, the logic would operate but would give negative outputs instead of positive ones. Gates with negative outputs like this are called NAND and NOR gates.

Practical gates may have different and more complex circuitry from that shown here. But the details are basically the same.

BINARY

If numbers can be expressed in binary form then they can be represented by binary voltages, like the logic signals we have been talking about. And like the signals, they can be manipulated by logic circuits. Combinations of gates can perform the function of addition and subtraction.

If you can add you can multiply; 4×3 is the same as $3+3+3+3$. You can also divide by repeated subtraction: $6\div3=6-3-3$. Count the number of times you can take 3 away and you have the answer, 2. These methods of multiplying and dividing may seem tedious. But a computer operates very quickly and never gets bored.

As to expressing numbers in binary form, this can be seen as a possibility from Bacon's cipher. His 32 combinations of five A and B units could be used for the numbers 0 to 31. The scheme is easily visualised by counting on your fingers in an unusual way, Fig. 10.6a.

Each digit is given the value shown. If it is extended, it signifies that number. If not it signifies 0. So the other arrangement shown, Fig. 10.6b, signifies $1+0+4+0+16=21$. By extending the appropriate fingers any number from 0 to 31 can be indicated. Try it for yourself.

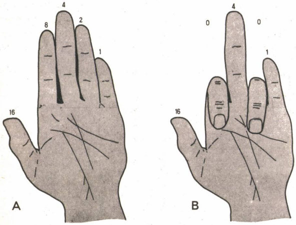


Fig. 10.6a. How to count to 31 using five digits. The number shown in (b) is 21.

Numbers coded in this way can be written down by putting 1 for any finger which is extended and 0 for any not extended. So the number in Fig. 10.6b can be written as 10101. The position of the digit in the sequence shows its value. Thus the 1 in the middle means 4 in ordinary decimal numbers. It turns out that binary numbers can be added, just like decimal numbers.

All you have to do is remember that you have to carry a 1 if the digits add up to 2, because 2 is 10 in binary. Try an example:

$$10+11=101$$

In decimal this is:

$$2+3=5$$

Check this on your fingers.

FLIP FLOPS

There are of course other circuit arrangements used in computing which are also of general interest, the first is something which you should recognise as a two-stage amplifier with positive feedback. Fig. 10.7.

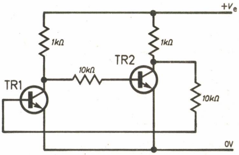


Fig. 10.7. A flip-flop circuit, drawn to show the d.c. feedback arrangement.

Instability is a possibility in positive feedback circuits. This one, however, is direct-coupled throughout, so there can be no a.c. oscillation as a result of the feedback. There can only be "d.c. oscillation". That is, the currents and voltages just keep on growing and growing until the amplifier overloads and they can grow no further. When this state is reached one transistor is conducting as much current as it can and the other not at all.

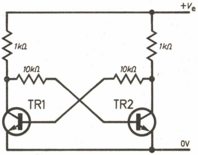


Fig. 10.8. The flip-flop is normally seen in most text books as above. The symmetry is clearly seen.

The circuit is usually drawn as in Fig. 10.8 in such a way that its essential symmetry is emphasised. If you construct this circuit but incorporate l.e.d.s as shown, Fig. 10.9, you can easily confirm that one transistor stays on all the time and the other off. It is necessary to use plain BC108's, not your NPN modules, because the protection resistors in the modules prevent this circuit from operating.

The symmetry of the circuit suggests that it is a matter of chance which transistor conducts. This would be so if the circuit were perfectly symmetrical, but in practice one transistor turns on faster than the other when the circuit is switched on. That is the one whose l.e.d. lights. However, if the "on" transistor is turned off by temporarily shorting its base/emitter junction, along the appropriate dotted line, this gives the other a head start. When the short is removed the other stays on. Short *its* base/emitter and the situation is reversed, and so on. You can make the circuit change from one state to the other as many times as you like.

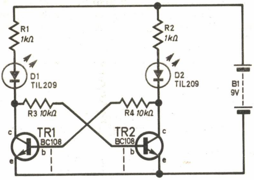


Fig. 10.9. A practical flip-flop circuit can be built using standard components. The action can be proved by shorting the base of each transistor (shown dotted) to earth.

There is clearly a possibility that the circuit's state can be changed by injecting pulses of voltage or current into the "on" transistor turning it off. Arrangements can also be made whereby turn-off pulses can be applied to both transistors at once, but only the "on" transistor actually feels them. This guarantees that the circuit changes state every time.

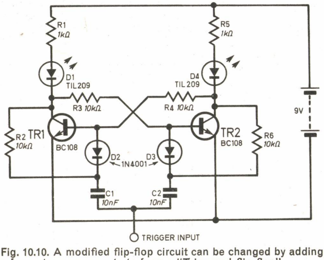


Fig. 10.10. A modified flip-flop circuit can be changed by adding a few extra components to form a "Triggered flip-flop".

The arrangements consist of added diodes, resistors and capacitors, Fig. 10.10. Only negative-going trigger pulses can turn the circuit off. Positive-going pulses have no effect. This means that if a.c. is applied to the triggering point only negative half-cycles have any effect.

The consequence is that if an output is taken from one collector an output pulse is generated only once every two cycles of the input. The circuit divides the input frequency by two. A further circuit will divide by four, a third by eight, and so on. In other words, one circuit divides by 2, two by 2×2, three by 2×2×2 and so on.

Integrated circuits containing long chains of these Eccles-Jordan bistable flip-flops, often just called bistables, are made, and they can divide by very large numbers all in powers of two. They can also be made to divide by numbers which are not powers of two, by applying feedback which resets the circuits to their initial state when the appropriate number of divisions has been made.

A common arrangement is the divide by ten, usually called a decade counter.

MULTIVIBRATOR

If the simple flip-flop is modified by using capacitors to cross-couple the two transistors it becomes a widely used oscillator known as a **multivibrator,** Fig. 10.11. If the circuit is truly symmetrical each transistor conducts hard for exactly half the time and is cut off for the other half. The voltage at either collector is a 50/50 square wave as shown.

The period depends on *R* and *C* and is about 900Hz for the values shown.

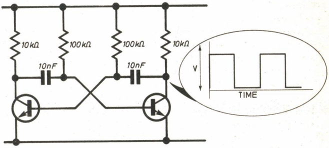


Fig. 10.11. By "cross coupling" the two transistors the basic flip-flop circuit can be changed into a multivibrator.

The protection resistors in your NPN modules prevent this circuit from working but a minor change enables it to function although at a reduced frequency, Fig. 10.12. If an output is taken from either collector to the trigger capacitors of your stable, Fig. 10.10, you have an electronic heads-or-tails machine. The bistable changes state continuously and very rapidly, so both l.e.d.s light. If the trigger is removed (or the multivibrator switched off) which-

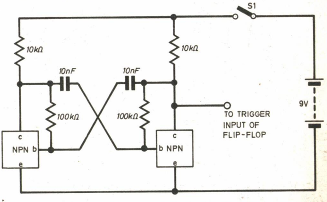


Fig. 10.12. For building a practical circuit using your NPN modules, a slight change is necessary for the circuit to function correctly.

ever l.e.d. is alight at the instant when the triggering stops remains alight. It is a matter of chance which one stays on, so if one l.e.d. is called "heads" and the other "tails" you can play games with the circuit.

Long chains of bistables can be made to do another job. If all the appropriate transistors are triggered at a steady rate, by an associated oscillator sometimes called a clock pulse generator, pulse information fed into one end of the chain passes along step by step and eventually emerges at the other end. This **shift register** arrangement can be used as a temporary store for pulsed digital information or as a **digital delay line.**

MONOSTABLE

The uncertainty about which transistor of a bistable will come on when the circuit is switched on makes it unsuitable for some purposes. A circuit where there is no doubt about which transistor comes on is sometimes required. Such an arrangement is the Schmitt trigger, Fig. 10.13. If the slider of VR1 is moved to earth, TR1 is off, TR2 is then turned on because R3 acts as its base bias resistance. If the slider is at the supply rail TR1 is on and TR2 is off.

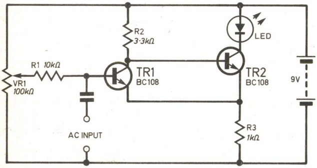


Fig. 10.13. A very popular "building" circuit, the Schmitt trigger. By biasing one transistor hard on, a large a.c. input causes periodic changes of state. The output is a square wave.

You might think that there must be some intermediate setting of VR1 at which both transistors are on and the l.e.d. just glows dimly. Try to find it and you will discover that the circuit jumps abruptly from one state to the other. You then have to move VR1 quite a bit to get the circuit back the way it was. This behaviour is called **backlash.**

If a.c. of sufficient amplitude is applied to the base of TR1 the circuit changes state periodically, snapping from one state to the other very quickly. The Schmitt trigger is often used like this to generate square waves from sine waves. The variable resistor, VR1 can be set so that exact 50/50 square waves are generated.

The trigger circuits we have looked at so far have had either all d.c. feedback couplings or all a.c. If one feedback coupling is a.c. and the other d.c. a **monostable** circuit can be produced. This remains quite stable in one state until a trigger pulse is applied. Then it flips temporarily to the other state until the coupling capacitor charges or discharges. Then it reverts to normal.

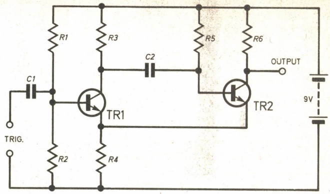


Fig. 10.14. A monostable circuit. When an a.c. input is applied, pulses of fixed duration are produced.

If the trigger pulse is short, the duration of the abnormal state is controlled by the *CR* time constant of the a.c. coupling. So the monostable can be used to generate pulses of known duration. In a monostable derived from a Schmitt circuit, Fig. 10.14, TR1 is normally off and TR2 on. A positive trigger pulse turns TR1 on and TR2 off, for a time which can be set by varying C2 or R5.

Next month a wide variety of subjects will be discussed under the broad title of Transducers.

QUESTIONS

10.1 Which of these is *not* a binary code;
- a. 49944994
- b. ABBCCBCC
- c. ???+++??+?+?++

10.2 If you had eight digits, what is the highest number in binary you could count up to?
- a. 255
- b. 16
- c. 34

10.3 Adding an inverter to an OR gate turns it into;
- a. an AND gate
- b. a NOR gate
- c. a bistable

10.4 What is the sum of the following binary numbers in decimal: 11+1001+1010+1
- a. 23
- b. 15
- c. 4

10.5 Which type of gate would you require to perform the logic operation $A+B=\overline{C}$;
- a. A NAND gate
- b. A NOR gate
- c. An INVERTER

ANSWERS *(To Part Nine)*

9.1. 700kHz (b)

9.2. the frequency of the tranmission (a)

9.3. 799, 800 and 801kHz (c)

9.4. 2·998MHz (c)

9.5. 30kHz (a)

POWER SLAVES IN ACTION!

By E. M. Lyndsell

In last month's issue were featured full constructional details for building a 100 Watt Power Slave amplifier suitable for use in the pop group, PA, disco and hi fi fields. Now we shall be looking at possible arrangements in these areas where the power slaves could be successfully employed.

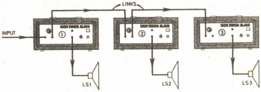


Fig. 1. Using the parallel-wired input sockets to link up three power slaves producing a 300 watt system.

FACILITIES

Two versions of the slaves were described, these being for 4 ohm or 8 ohm speaker loads into which 100 watts r.m.s. could be realised. The front panel controls, inputs and output sockets are the same in both cases. Besides the on/off switch only one control was included, this being a volume control although in some applications this is considered superfluous where it is left at maximum setting and the volume controlled from the preamplifier stage.

PARALLEL WIRED SOCKETS

The slave is equipped with two input sockets wired in parallel but use of one of these is reserved for linking to other power slaves when output powers greater than 100 watts are required. This means of inputting to additional slaves eliminates the need for multiple long runs of screened cable from preamplifier to each slave, Fig. 1.

This clearly has advantages as can be seen in the photographs last month, besides being economical on screened lead and preamplifier outlet sockets.

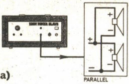
Two output sockets wired in parallel were included as a convenient means of splitting the speaker load allowing distribution of the sound for example to speaker cabinets situated in left and right areas on stage. Further distribution can be achieved by additional runs of cable between these speakers and each additional cabinet; for this an extra parallel wired socket is required on each cabinet. One advantage of this idea is the reduction in lengths of required speaker cable and less congestion at the amplifier front panel.

LOUDSPEAKER IMPEDANCE

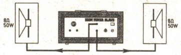
As can be seen from Fig. 2 last month, the inclusion of the short-circuit protection network allows the power slaves to safely handle a wide range of speaker loads, but will only deliver full output (100W) for a single value load i.e. 4 or 8 ohms.

The realisation of these impedances can be achieved by many different speaker impedances connected in series, parallel and series/parallel arrangements. Now heavy duty speakers designed for pop and disco work are generally only available in 8 or 15 ohms, so only these will be considered in the suggested arrangements in Fig. 2. The total resulting impedances in some cases (c), (e), (g), (h) and (i) are slightly below the nominal values of output load (4 and 8 ohms), but the resulting reduction in maximum output power is unnoticeable to the ear.

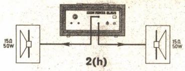
In systems involving multiple speakers, some of these can represent horns for improved high fre-



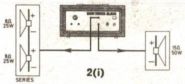
2(a)



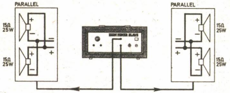
2(b)



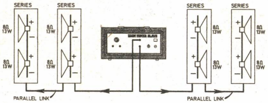
2(h)



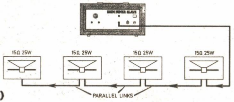
2(i)



2(c)

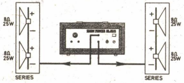


2(d)



2(e)

2(f)



2(g)

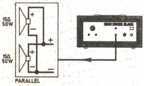


Fig. 2. Arrangements of 8 ohm and 15 ohm loudspeaker drive units to produce suitable systems for the two versions of the power slave; (a) to (e) are suitable for the 4 ohm version and (f) to (i) are suitable for the 8 ohm version. The total load as seen by the slave amplifier in each of these arrangements is: (a) 4 ohms, (b) 4 ohms, (c) 3·75 ohms, (d) 4 ohms, (e) 3·75 ohms, (f) 8 ohms, (g) 7·5 ohms, (h) 7·5 ohms, (i) 7·7 ohms.

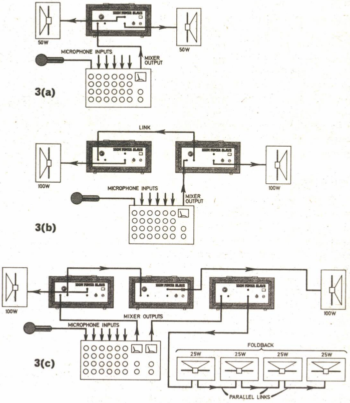


Fig. 3. Use of the power slaves in a pop group PA system incorporating a multichannel mixer; (a) 100 watt, (b) 200 watt, (c) 200 watt main channel with 100 watt foldback system.

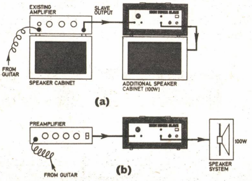
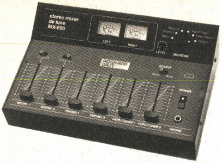


Fig. 4 (a). Increasing the output power capability for an electronic instrument (or PA) via the slave output socket on the existing equipment and (b) forming the amplification equipment for instrument with a suitable pre-amplifier.



A mini stereo mixer, the Howland West MX690 with facilities for two microphones, two record deck cartridges and two tape/ tuners.

quency performance, but cross-over networks will need to be employed for best results. High impedance piezo-horns are currently fashionable and these can be wired directly in parallel with any of the shown arrangements with virtually no effect on total load impedance. No cross-over network is required for this type of horn.

POP GROUP

In the pop group it is thought that the power slaves will mostly be used in the PA system and will be fed from a mixer. This usually has six or more inputs and one or two (sometimes four) outlets. Besides mixing the signals, they are boosted in level and can be tailored with bass, midrange, and treble, boost and cut and other effects such as reverberation, echo and phase.

A typical 100 watt PA system is shown in Fig. 3a. The speaker load is split as previously mentioned and can be of any speaker combination to provide the correct loading to suit the slave built.

For increasing the total output power, a second slave can be linked as shown in Fig. 3b. The required speaker system handling capacity is now twice that of Fig. 3a. Further links can be made in a similar manner.

It is surprising that with all the amplification in use on stage by a pop group, the people who find it difficult to hear what is being played are the performers, especially the vocalists. To overcome this a foldback system is employed. This requires a second outlet on the mixer, through which selected channels can be fed to another power slave loaded with foldback or monitor speakers. These are facing the performers, hence the name foldback. Such a set-up is shown in Fig. 3c. This is used by the group who appeared in the June issue.

Well known by professionals, this mixer costing about £1650 and manufactured by Macinnes Laboratories has 18 microphone or line balanced inputs with a total of 9 output channels, (4 master, 2 echo, 2 foldback and 1 headphone).

For the musician a power slave can be employed to (i) increase his power output capability by linking from his existing amplifier (preamp and power amplifier combined) to a power slave. Many commercial amps are nowadays equipped with a slave output socket for such a purpose, see Fig. 4a; or (ii) as his amplification equipment when preceeded by a suitable preamplifier, see Fig. 4b.

DISCO

On the disco scene the power slave has similar applications to that in the pop group in so far as having two main areas of employment (i) increasing output power level or (ii) forming the power output stage of a disco set-up. In the majority of disco set-ups a stereo system is used. A typical set-up for requirement (i) is shown in Fig. 5. For the second requirement ignore the "existing" equipment, stereo amplifier and speakers.

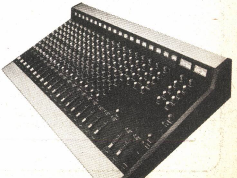
The disco console is fitted with a stereo preamplifier incorporating equalisation etc. suitable for inputting to a power slave.

HI FI

The performance of the power slave was thought good enough by the author and others to be grouped in the hi fi category when used with a suitable preamplifier. It was however never tested at full power in this mode since the speakers for this power level were not available and secondly the signal source was only about 200 millivolts being derived from the tape output socket of a commercial hi fi amplifier. The amplifier can safely handle hi fi type enclosures which are normally equipped with cross-over networks and appear highly reactive. The short-circuit protection has been designed to accommodate this kind of load.

It is important to obtain a preamplifier with sufficient output level (at least 775 millivolts) to drive the power slaves to full power. The sensitivity of the slaves may be increased by altering the values of the feedback resistors R5 and R6. For increased sensitivity, R6 should be increased and/or R5 decreased. If decreasing R5, capacitor C7 needs to be increased in value so as to avoid premature low-frequency roll-off. The changes involving R6 have not been carried out by the author. ⌑

A popular mixing console to be found in use by many present day bands, the Hill 16/2B. This unit has 16 balanced inputs and two master output channels. Other facilities include PFL, pan, 4-band equalisation and twin foldback on each output.



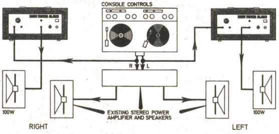
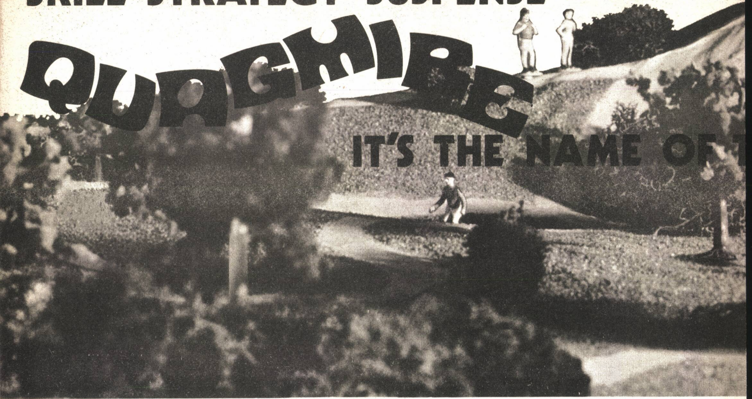


Fig. 5. Increasing the output power of a stereo disco set-up by 200 watts—100 watts per channel. All the necessary equalisation will have been taken care of in the console preamplifier.

SKILL · STRATEGY · SUSPENSE

QUAGMIRE

IT'S THE NAME OF T



QUAGMIRE is an electronic game of suspense, skill and strategy for 2, 3, or 4 players. It is a *true* electronic game and not a simulation of a game more usually played in other ways (for example TV football, squash, electronic noughts and crosses etc) but a new game in its own right, that cannot be realised in any way except by electronic means.

Briefly, the board bears a number of touch-plates (the "danger-spots"). A lamp on the board flashes regularly, slowly at first, but at an increasing rate as more touch-plates have been contacted in certain combinations. Eventually, touching one of the plates (it is almost impossible to work out in advance which one it will be) causes the lamp to be extinguished, and the player loses one piece. (Rules and playing instructions are given later).

CIRCUIT DESCRIPTION

The complete circuit diagram of the Quagmire game is shown in Fig. 1 and can be seen to consist of distinct sections: touch-switches, bistables, oscillator, latch, and logic circuitry and we shall deal with them in this order.

The touch-switches all have the same design though the values of R5, C5 used in touch-switch *E* are different from those in the other touch-switches. When the touch-plate is contacted, this causes a change of potential at the gate of the field-effect transistor. The result of this is that the resistance between the source (s) and drain (d) terminals suddenly increases, bringing about a sharp drop of potential at the source terminal with respect to 0V. The output of the switch falls from about 4·5V (3V in switch *E*) to almost 0V when the plate is touched.

The function of the by-pass capacitor is to damp out small fluctuations and spikes in the output voltage, so that the next stage is triggered only when the plate is touched. The larger value of C5 means, that once switch *E* has been touched, its output goes low immediately, and remains low for several tens of seconds.

As we see in Fig. 1, several touch-plates are connected to each touch switch. Those connected to switches *A, B* and *C* are pairs of danger-spots in the central region of the board; these are not necessarily adjacent danger spots. The plates connected to switch *E* are scattered around the edge of the board.

BISTABLES

There are four bistables in all and each bistable is built from two NAND logic gates. All the necessary gates are contained in two i.c. packages, IC1 and IC2. The action of these is best described with reference to Fig. 2.

Normally, both inputs are high (greater than about 4·5V) and the output is either low (close to 0V, *state A*) or high (*state B*).

In state *A* the inputs and output of both gates are in agreement with the NAND truth table, so the circuit is stable. If input *A* is momentarily made low, the output of gate *A* must go high; now the circuit is in a transition state. Instantly, the high input to gate *B* causes its output to go low. Once again the inputs and outputs of both gates are in agreement with the truth table, and the circuit is stable in this state, state *B*.

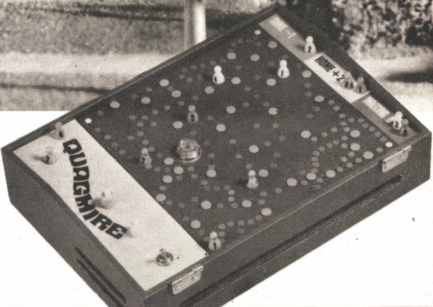
To make the circuit change back to state *A*, we must make input *B* low. Note that once the bistable has been made to change state by making one of its inputs low, that

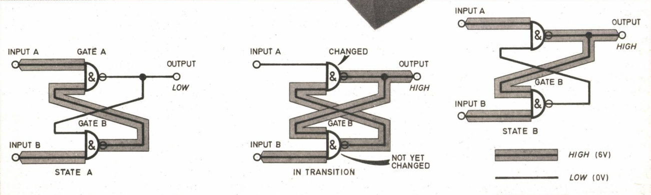
E GAME

By O. N. Bisho

input can be made high again without making the bistable change back to its previous state.

The bistables in Quagmire are connected to the touch switches (*A* to *D*) by input *A*, so their output goes high (state *B*) when the connected switches are touched. Their *B* inputs are wired together and to a resistor R6, which holds them at high potential. When S1 is pressed, all bistables are reset to state *A*.





INPUT		OUTPUT
L	L	H
L	H	H
H	L	H
H	H	L

Fig. 2. The operation of the bistables in stages and the truth table for a NAND gate.

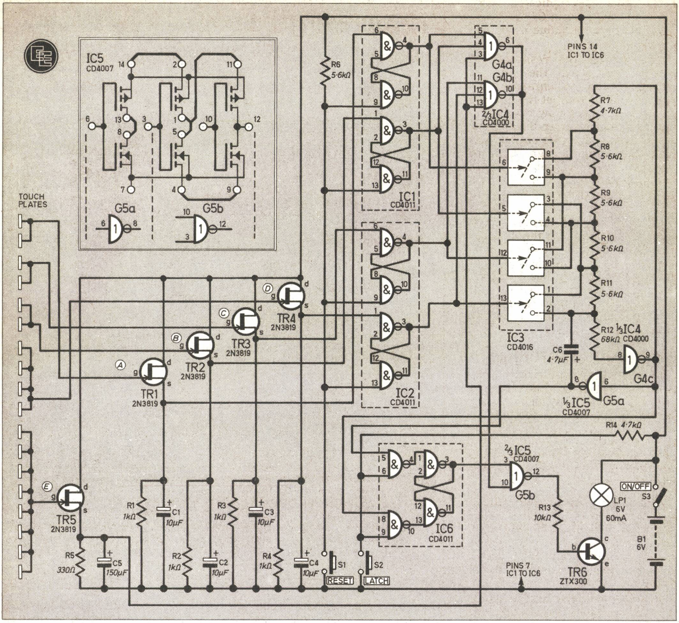


Fig. 1. The complete circuit diagram of the Quagmire game. The inset contains internal details of IC5 and the necessary linking to realise the two gates, G5a and G5b.

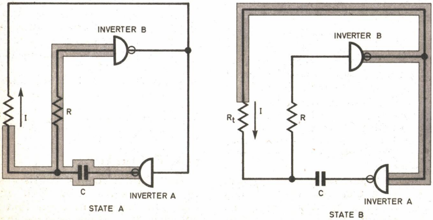


Fig. 3. The operation of the oscillator circuit composed of two CMOS inverter gates.

OSCILLATOR CIRCUIT

The oscillator is needed to make the lamp flash. In a simpler form its action is shown in Fig. 3.

Like the bistable, it can exist in two states, but it is not stable in either state, so it is called an astable multivibrator. It is built from two CMOS inverter logic gates.

In state *A*, the output of inverter *A* is high, so the potential of *C1* is high and also the input to inverter *B*. The output of inverter *B* is therefore low, together with the input to *A*. There is a large potential difference between the two ends of R_t, causing a current

COMPONENTS

Resistors

R1	1kΩ	R8	5·6kΩ
R2	1kΩ	R9	5·6kΩ
R3	1kΩ	R10	5·6kΩ
R4	1kΩ	R11	5·6kΩ
R5	330kΩ	R12	68kΩ
R6	5·6kΩ	R13	10kΩ
R7	4·7kΩ	R14	4·7kΩ

All ⅛ watt carbon ± 10%

See
Shop Talk
page 547

Capacitors

C1 to 4	10μF 6V elect. (4 off)
C5	150μF 6V elect.
C6	4·7μF 10V tantalum

Semiconductors

TR1 to 5	2N3819 *n*-channel field effect transistor (5 off)
TR6	ZTX300 silicon *npn*

Integrated circuits

IC1	CD4011 CMOS quad 2-input NAND
IC2	CD4011 CMOS quad 2-input NAND
IC3	CD4016 CMOS quad bilateral switch
IC4	CD4000 CMOS dual 3-input NOR plus inverter
IC5	CD4007 CMOS dual complementary pair and inverter
IC6	CD4011 CMOS quad 2-input NAND

Miscellaneous

S1	s.p.s.t. toggle
S2, 3	push-to-make, release-to-break push button switch—different colour fixing rings (2 off)
LPI	6V 60mA in panel mounting holder
B1	6V SP2 or SP11 1·5 volt cells (4 off)

Stripboard 0·1 inch matrix 36 strips by 29 holes; 14 pin d.i.l. sockets (6 off) or Soldercon pins (84 off) 0·1 inch type Veropins (10 off); battery holder to suit B1; 25mm long 6BA bolts, (2 off); 6BA nuts (6 off) 6BA shake-proof washers (4 off); 6BA solder tag (1 off); 6BA plain washer (1 off) materials for making case and panel; sheet aluminium kitchen foil; card; coloured paper; coloured position marker "spots", 4 yellow approximately 150 green (Boots); brass-plated drawing pins with red plastic-covered heads (34 off); epoxy resin adhesive; contact adhesive; scrap plastic-covered mains flex; Halma pieces or 10mm diameter dowelling (4 off each of 4 colours); connecting wire; solder.

I to flow, as indicated. This gradually discharges *C1*, at a rate dependent on the value of *C1* and the value of R_t.

The greater the resistance of R_t, the more slowly the capacitor is discharged. Eventually, the potential of *C1* (and at the input to inverter *B*) falls below the switching level, and inverter *B* has a low input. Immediately its output goes high, providing a high input to inverter *A*. The output of *A* goes low and the potential of *C1* goes low too. Now the astable is in state *B*.

In this state current flows through R_t, though in the opposite direction, charging *C1*. When it is charged to a sufficiently high potential, inverter *B* has a high input and the astable reverts to state *A*. The cycle continues indefinitely at a rate which can be altered by altering the value of R_t.

ELECTRONIC SWITCHING

In the Quagmire circuit electronic switching is employed to alter the value of R_t which is represented by the resistor chain R7 to R11. IC3 contains a set of four switches by which any one or more of resistors R7 to R10 may be short-circuited and effectively removed from the chain.

When the control input to a switch is low, the switch is open; when the control input goes high, the switch is closed and current can flow through it instead of passing through the associated resistor.

At the beginning of the game, when all bistable outputs are low, all switches are open and the charging current flows through all resistors—a total of 27·1 kilohms. As the bistables become triggered one by one, the corresponding switches are closed and the effective resistance of the chain decreases in steps of 5·6 kilohms to 4·7 kilohms. As this happens the rate of flashing of the lamp becomes faster and faster.

LATCH CIRCUIT

The latch consists of four NAND gates, all contained in IC6. Two of the gates are connected to form a bistable. When the input to the other two gates is high, an alternating input to these gates causes an alternating output. The input to these gates come from the oscillator circuit, on either side of inverter *A*, so that when one is high the other is low. Thus, as the oscillator changes state, a low input is directed to each gate of the bistable, in turn, which also changes state.

If S2 is pressed, each of the gates wired to it has a low input and then, no matter what the state of its other input, the gate output is high. The bistable remains in whatever state it was in when the button was pressed. This is how the pressing of S2 causes the lamp to stop flashing and remain either on or off for as long as the button is held.

The output from the bistable goes to a NOR gate (G5b), which also receives an input from the logic circuit, in fact, it is part of the logic circuit. The output of a NOR gate is low whenever any one or more of its inputs is low. If the output from the connection of G4a and G4b is low, and that from the latch is alternating, an alternating output from G5b is obtained. Pulses of base current are supplied to TR6, which is turned on and off regularly, causing the lamp to flash (unless S2 is pressed when it will stop, either on or off). If the output from G4a/G4b goes high, the output of G5b goes low, the lamp is extinguished, forcing the player's piece out of the game.

LOGIC CIRCUIT

The logic circuitry consists of three NOR gates (G4a, G4b and G5b) and behaves in a way that is not easily predictable, and we shall not attempt to describe its action here. The input provided from touch-switch *E* is verging on the borderline between high and low, there are many stray pulses wandering around the Quagmire circuit that may set or reset the bistables individually without the operation of touch-switches or S1; finally there is a WIRED-OR connection between the outputs of G4a and G4b. All these factors combine to make the operation of the logic circuits rather illogical.

When designing the prototype the author found the the WIRED-OR connection made it possible to obtain the sort of partly logical and partly unpredictable behaviour that was required, using the minimum number of gates. It was thought that the circuit behaviour should model that of a quagmire—one can make a statistically sound prediction of what should happen when you land on a danger-spot, but you can never be quite sure of the eventual result, whether you sink or survive.

Having built the circuit, the author then consulted the data book and found that WIRED-OR connections are *not allowed* with CMOS circuits. Allowed or not, this one produces the right kind of effect for the game.

When you have completed this circuit you will be able to see how even a simple set of gates can develop a mind of its own, and begin to wonder when some of our computers will begin to behave in the same kind of way.

START HERE FOR CONSTRUCTION

CONSTRUCTION

As can be seen in the photographs and drawings, a large number of interwiring connections are required to be made which could prove troublesome for the novice constructor but should not be beyond his capabilities if tackled in an orderly manner.

In an effort to make construction and wiring easy to follow, the components and interwiring on the topside of the stripboard are shown in separate drawings, Fig. 4a and 4b. The author suggests that the unit be built in stages and each stage tested before proceeding to the next.

The board used in the prototype was 0·1 inch matrix stripboard size 36 strips × 29 holes. Begin by cutting the board to size, drilling the two fixing holes and then making the breaks on the underside according to Fig. 4c. Veropins are used for some wiring to make construction easier. These should next be inserted and soldered in place.

In the prototype the i.c.s were soldered directly to the component board, but it is recommended that i.c. sockets or Soldercon pins be used. The usual precautions for handling CMOS must be observed.

With reference to Figs. 1 and 4b, make the interconnections around IC1 and IC2, not forgetting those to the battery supply rails and then insert IC1 and IC2 in their holders. To test these bistables, use a loose wire connected to the ground rail (battery negative) and touch it against the *A* inputs of each bistable in turn. A voltmeter connected to the output wire should show a sharp rise from low to high. Then touch the reset pin with the grounded wire; the output should fall sharply to zero.

Next assemble the touch-switch components, and connect them to the inputs of the bistables. There is no need for touch-plates at this stage. To test a switch, simply touch the appropriate terminal with your finger; observe the change in output of the bistable, by using a voltmeter.

OSCILLATOR COMPONENTS

Next build the oscillator. The inverters for this are contained in IC4 (input pin 8, output pin 9) and IC5 (input pin 6, output pin 8). The latter i.c. the CD4007, known as a Dual Complementary Pair and Inverter is a versatile CMOS i.c. consisting of an array of six MOS transistors. By suitable external wiring, these can be connected to make several combinations of logic gates. Here they are wired to make an inverter (G5a) and a 2-input NOR gate (G5b). To build the oscillator you need both i.c.s in position, with R12 and C6 connected to them. All the wires connected to IC4 and IC5 must be soldered in place at this stage.

Those inputs that are not currently being used (IC4, pins 3, 4, 5, 11, 12, 13) should be temporarily connected to the ground rail. Connections between IC4 pin 10 and IC5 pin 10, and between IC4 and the latch inputs should also be made. For the moment, do not assemble TR6 and its associated components.

Temporarily wire a resistor value about 22 kilohms between holes *T*2 and *H*4. This is a substitute for the resistor chain, allowing you to test the oscillator before wiring up IC3. When all is complete, insert IC4, IC5 and IC6 and switch on; apply a voltmeter probe to pin 6 and 8 of IC5. The needle should show rapid kicks at about 1 hertz. The output of the latch (IC6, pin 11) should show a similar kicking, and grounding the latch terminal pin (hole *K*13) should result in the meter reading becoming steady—either high (6V) or low (0V).

BILATERAL SWITCH

Next assemble IC3 (the quadruple bilateral switch) and the resistors and other connections associated with it, except those to IC4 and IC5. The action of this can be tested by connecting an ohmmeter across points *X*20 and *S*12. When the reset terminal pin (*X*23) is grounded, all switches should be open and the total resistance of the chain should be 22·4 kilohms. As you touch the input pins of touch-switches *A* to *D* in turn, the resistance reading should drop to 16·8 kilohms, then 11·2 kilohms, then 5·6 kilohms and finally to zero.

Now solder resistor R7 in position and the wire connecting IC3 (*X*20) to capacitor C6 (*H*4). The chain of resistors is now part of the oscillator circuit, and the temporary 22 kilohm resistor should be removed, if it has not been removed already.

Complete the remainder of the board wiring, including all inputs to IC4 which were previously connected temporarily to ground. solder in position R13 and TR6. With a temporary connection to the lamp, you can now test the whole circuit.

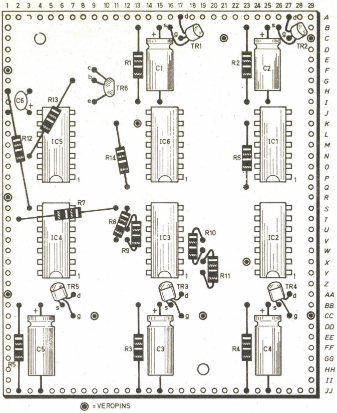


Fig. 4a. The layout of the components on the topside of the stripboard. Orientate the i.c.s. with reference to the indentation at one end.

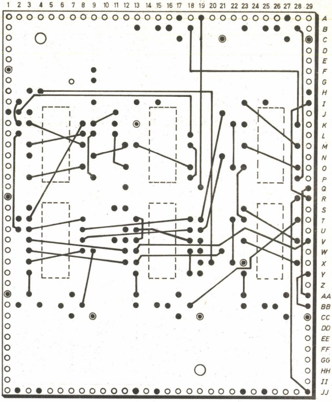
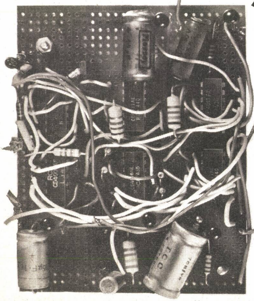

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA BB CC DD EE FF GG HH II JJ

Fig. 4b. The circuitry to be carried out on the topside of the stripboard after components have been positioned and according to instructions.

QUAGMIRE



The completed component board of an early prototype.

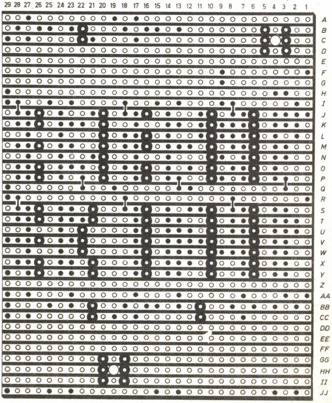

29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA BB CC DD EE FF GG HH II JJ

Fig. 4c. The underside of the stripboard showing breaks in the copper tracks and link connections to be made.

Ground the reset pin (*X*23) the lamp, if not already on and flashing, should begin to flash at its slowest rate. Remove the ground connection from the reset pin. Then touch the input pins of the touch-switches in turn, using your finger. The rate of flashing should increase by stages, eventually becoming so fast that the lamp almost appears to glow at half strength. At some stage the lamp becomes extinguished, showing that the logic circuit has had its effect.

If the circuit is left untouched for long enough, the lamp will eventually brighten and begin to flash again, though rapidly. Grounding the reset pin will make it resume flashing at its slow rate almost immediately. Ground the latch pin (*K*13) the lamp should stop flashing and remain on or off until the connection between pin and ground is broken. If all is well, preparation of the case and top panel can commence.

TOP PANEL

It is often convenient to use a ready-made wooden box of suitable size. For the prototype the author was lucky to have an old record-player case available. If a ready-made case is not to hand, it is a simple matter to construct a case from blockboard or plywood. The exact dimensions are not critical. The internal dimensions of the author's cabinet are 320 x 230 x 60 mm.

ZONES

The top panel is made from thinner plywood or hardboard. Thin card of suitable colour (e.g. brown) is stuck to the top surface of the panel and holes drilled for the lamp and switches. Then the plan of the playing board is drawn or painted on the card. A half-scale plan of the prototype board is shown in Fig. 5. The "home" spots and "safe" spots can be marked by using the coloured self-adhesive discs sold for "spotting" photographic slides; these are available in packets containing several hundred spots in red, yellow and green.

The "danger" spots are marked by plastics-covered drawing-pins (red) some of which form the touch-plates. Drill holes about 2mm diameter centred on the point where each danger spot is to be. Strip the plastics insulation from a short piece of mains flex and cut this into pieces about 4mm long. Thread a piece on to each pin, pushing it up toward the head as shown in Fig. 6 so that the point of the pin projects below the plastics sheath. Glue these into the holes bored in the panel using epoxy resin adhesive. Thirty-four such pins are used in the prototype, though only 18 are connected as touch-plates at any one time. The rest are dummies, whose purpose is to confuse the players.

Complete the board marking by cutting out pieces of coloured paper and sticking these in position to mark the areas beside the playing area where pieces are to be placed when "waiting", "home" or "sunk". The appropriate scores can be marked on these areas.

SCREENING

The reverse side of the top panel needs to be covered with a sheet of aluminium kitchen foil to the same size as the panel, and glued to the underside of the panel,

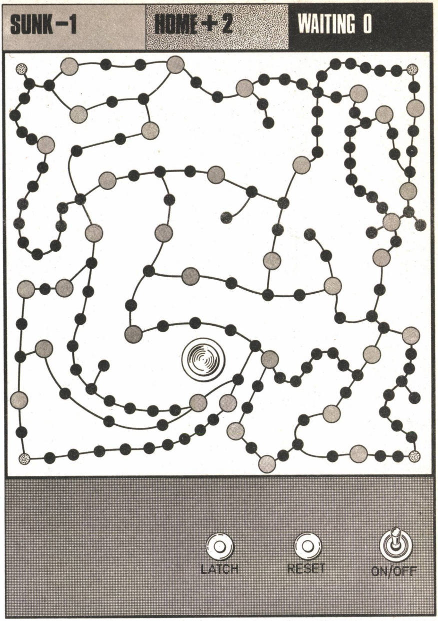


Fig. 5. A plan view of the playing area showing the pathways used on the prototype (half-scale) and the position of the panel mounted switches and lamp.

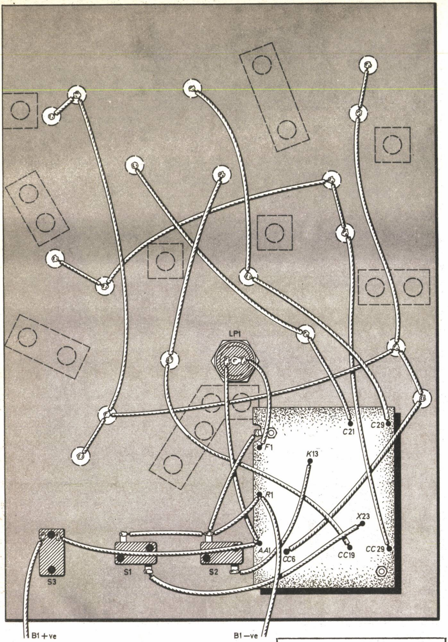


Fig. 7. Underside view of the top panel showing complete wiring details from board to touch-plates and other panel mounted components. Note that the unused drawing pins have insulation tape covering them before the aluminium foil is laid.

NOTE: ***After the game has been played very many times, some players may begin to detect which danger spots are really dangerous, and which are really dummy spots, with no connection to the logic circuits. At this stage it is a simple matter to alter the wiring beneath the board, so altering the entire aspect of the quagmire.***

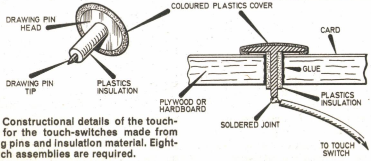


Fig. 6. Constructional details of the touch-plates for the touch-switches made from drawing pins and insulation material. Eighteen such assemblies are required.

and all the inner surfaces of the case using contact adhesive. Where the points of drawing-pins project from the board, press the foil flat so that they penetrate it, and then peel away the foil from a circular area about 5mm in diameter around each point. The foil acts as a shield to prevent the picking up of electrical disturbances by the wires joining the pins to the circuit board. Make holes in the foil where the lamp and switches are to be mounted. Drill two 6BA holes for the bolts on which the circuit-board is to be mounted. The lamp, switches and board may now be mounted on the panel.

One of the board mounting bolts has a solder tag and washer fitted to it, and the nut is tightened to bring the tag/washer into good contact with the aluminium foil. Bolt the battery holder to the floor of the case and then complete the off-board wiring, according to Fig. 7.

You may find it difficult to make durable solder connections to the drawing pins. A good joint is helped by cleaning the tip of the pin with a fine file, just before attempting to solder the lead to it. Leads between pins and circuit board should be kept as short as possible. Make sure that no bare wires touch the foil.

EARTHING

The ground rail of the circuit board is connected to the foil by means of the solder tag already referred to. When all connections have been made, the panel is bolted into position and the whole system may then be tested.

You may find that resetting is very slow, or that the system is too prone to spurious triggering when you merely wave your hand over the board. This can generally be cured by earthing the system.

One of the bolts fixing the battery-holder is connected to battery negative and the foil lining the case. The head of the bolt, outside the case should then be fitted with a piece of springy brass to make contact with the surface on which the case is resting. This will probably give sufficient earth connection. If it does not, try running a wire from the bolt to the nearest earth point (e.g. floor of room).

QUAGMIRE RULES OF PLAY

AIM OF THE GAME

The board represents a quagmire and the aim of each player is to get as many pieces across from one corner of the quagmire to the opposite corner as quickly as possible and without losing any by sinking at the danger spots. Each player has 4 pieces of the same colour, numbered 1 to 4. The pieces are first placed in the WAITING area at the side of the board.

THE BOARD

The board bears a large lamp that flashes at a speed indicating the amount of risk of sinking in a danger spot at that time. It is also used for deciding whether a piece is to be moved one step or two steps in its turn (see MOVING).

The board is marked with paths through the quagmire, on which paths there are spots:

HOME spots (yellow) Players begin and end journeys here.

SAFE spots (green) Players jump from one to the next (or next but one) as they move.

DANGER spots (red) If a piece is due to land on one of these, the player must touch the spot with a finger before placing the piece on the spot. If the lamp goes out, the piece is sunk in the quagmire, and is out of the game. It is immediately placed in the SUNK area at the side of the board. Pieces belonging to other players, or other pieces belonging to the same player, which are on other danger spots when the lamp goes out, are *not* affected.

To make the lamp begin flashing again, the RESET button (blue) is pressed and held until the lamp flashes at its slowest speed.

No two pieces may be on a spot at the same time. Pieces may not pass each other on the same path, or jump over each other.

MOVING

Moves are decided by pressing the STOP button (yellow). When this is pressed and held, the lamp stops flashing:

If it stops OFF, the piece is moved to the next spot on its path.

If it stops ON, the piece *jumps over* the next spot and lands on the one beyond. In this way a lucky player may jump over a danger spot and is not required to touch it with a finger. If a player is unlucky and jumps right on to a danger spot, the spot must be touched before landing there.

STARTING

Press the RESET button until the lamp flashes at its slowest rate. Place all pieces on the WAITING area. To decide who is to begin, players press the STOP button in turn. If the lamp stops ON, that player is in; if it stops OFF, that player is out. Players who are *in* press again, if necessary, until only one player is *in*. That player is first to play and has the choice of corner.

If there are only 2 players, they play from diagonally opposite corners of the board. Players place one of their pieces on their HOME spot. The first player then moves as instructed above, and other players follow in clockwise rotation.

PLAY

In subsequent turns, players may move the same piece or they may put another piece on the HOME spot and move that instead. Only one piece may be moved at each turn. All four pieces belonging to a player may be on the board "crossing" at the same time.

Before pressing the STOP button in turn, a player *must* announce which piece is to be moved.

Normally a piece is moved in a forward direction along its path; if a player wishes to reverse direction this must be announced *before* pressing the button.

A player *must* move one piece each turn, unless prevented from doing so by a blockage (see below).

ROUTES

Players may choose any route between their starting HOME spot, and their destination HOME spot at the diagonally opposite corner of the board. Routes across the centre of the board are shorter than those around the edges, but the danger spots in the central region have, on average, a higher probability of extinguishing the lamp and so sinking the piece.

At the beginning of the game, when the lamp is flashing slowly, the risks are small and it is reasonably safe to venture across the central region.

Each time a danger spot is touched by any player, the rate of flashing *may* increase, indicating increasing danger. When the lamp is flashing very rapidly, the next player to touch a danger spot is likely (though not certain) to be sunk.

After a piece has sunk, and the lamp has been reset to flash slowly, risks are reduced again for a while.

A player may wish to choose a route that avoids certain spots which are believed to be especially dangerous, or to avoid areas of the board blocked with other pieces—it could also be worth while to obstruct the path of a piece belonging to another player.

Note that some of the touch switches are triggered only at the first touch. A second piece arriving later at the same danger spot is not able to trigger it a second time, so the lamp will not be extinguished and there is no danger of being sunk. Players can take note of triggered spots to plan safe routes.

BLOCKAGE

Players may not overtake, or pass when moving in opposite directions. When the path of a piece belonging to player **A**, is blocked by a piece belonging to player **B**, player **A** may (but need not) challenge player **B** when it is **A**'s turn to move. **A** says either "on" or "off" and then presses the STOP button. If his guess is correct **A** wins the challenge. The turn then passes to **B**, who must move the blocking piece according to the number of spaces indicated by the lamp, turn by turn, until it has been backed to an intersection of paths and into a path that **A** does not want to use. **A** in turn must follow the retreating piece and then move away from the intersection along the chosen path.

After **A** has challenged **B** and until the winner of the challenge (**A**) has got clear of the blockage, neither player may move any other piece.

If **A** loses the challenge (wrong guess), the turn passes to **B** who may challenge **A** immediately, at a later turn, or never. After a lost challenge either player may move any other piece at the next turn.

HOME

A piece arrives home when it lands on its home spot. It is not necessary to obtain the exact number of moves, so if a piece is on the spot next to home, it can be moved home at the next turn. In the turn in which a piece arrives home it is removed from the board and placed in the HOME area at the side of the board.

ENDING THE GAME

A player must move one piece each turn as long as the rules above permit it. If it is a player's turn and no move is possible, the game ends. This happens when all the pieces belonging to a player have either been sunk or have reached home. Note that if a player cannot make any move because of one or more blockages, this does *not* end the game; in this circumstance, the player must challenge one of the blocking players, and this challenge constitutes his move.

SCORING

When the game ends, players total their scores as follows:

for each piece HOME	+2 points
for each piece CROSSING	+1 point
for each piece WAITING	0 points
for each piece SUNK	−1 point

PIECES

Each player needs four pieces of the same colour. You may have an old Halma set which will provide all that is required. If not, purchase a cheap set and use the pieces for playing both Halma and Quagmire. Alternatively, short lengths of 10mm diameter dowelling, coloured and numbered can be used.

For Quagmire, the pieces of one colour should be numbered 1, 2, 3 and 4. This is necessary, for it is one of the rules of the game that players must indicate which piece they intend to move *before* pressing the latch switch. If you point at the piece you intend to move the motion of your finger and hand may trigger a touch-switch. This sort of hazard is not really desirable; if the pieces are numbered, you call out its number instead of pointing.

Now gather together a few members of the family, young or old, and explain the basic rules of the game. See who can be first home across those Quagmire! ⌑

NO-FLASH FOR POLAROID CAMERA

BY R.H. MARCO

NOT surprisingly in this age of instant products, the popularity of the Instant Photograph has rapidly grown.

By far the most popular cameras in use for taking instant pictures are from the Polaroid range. Many types are on the market, from the simple black and white camera to the more advanced colour cameras.

The purpose of this article is to describe a simple modification which can be made to the Polaroid Land Camera to enable it to take black and white pictures without the need for flash.

It should be mentioned however that once the modification is carried out, the camera can never be used as the manufacturer's intended, for taking automatically exposed daylight colour photographs. Furthermore, the modification will invalidate the manufacturer's guarantee.

MODIFICATION

First locate the lighter/darker button on the front of the camera, and carefully remove this by sawing it off using a small hacksaw Fig. 1(a). Be careful to avoid damage to the lens and surrounding front.

Once the button has been removed it should be possible to locate a light dependent resistor within the camera body. This component is removed using a soldering iron with a very fine bit. Again be careful to avoid melting the plastic surround.

Cut the leads fairly close inside the hole ensuring that no excess is left inside. Now take the potentiometer VR1 and resistor R1 and wire them as shown in Fig. 1(b). This should be done with care as the leads are required to be short and may part company with the rest of the circuit. Attach short lengths of flexible wire to the wiper and the other end of the resistor, and solder the two ends to the wires inside the camera.

Having first made sure the joints are well made, the potentiometer can be carefully eased in place over the hole. A quick-setting epoxy glue or similar is then spread around the edge securing the potentiometer in place. Fig. 1(c).

Whilst waiting for the glue to set a scale can be marked and placed in position. A scale similar to Fig. 1(d) may be traced. Or if preferred the actual markings can be left off, and the scale calibrated once experience has been gained using the camera with different settings. This will provide a more effective scale than with arbitrary markings.

IN USE

With the l.d.r. removed from the camera the user now has manual control over the shutter speed. This could be proved by leaving the potentiometer out, thus the internal circuit will be open circuit. In this position the shutter is controlled entirely by the time the exposure button is held down.

This has been mentioned mainly for reference as an extra modification could be incorporated whereby the potentiometer could be switched out of circuit thus enabling long time exposures (measured in minutes) to be made.

The camera is, of course, loaded with black and white film as opposed to colour, and the flash cube removed. Some experimenting may be required to find the right settings of the potentiometer with differing light conditions.

Basically if the scene to be photographed is very dark then the shutter needs a long exposure, this means that *maximum* resistance is inserted in the circuit by the potentiometer. Conversely, if the scene is bright and well lit then a short exposure is required. In this instance the resistance should be *small*.

As mentioned earlier a more accurate scale could now be made up corresponding to the different levels of illumination. Thus once the user is familiar with the use and recognises similar light conditions the potentiometer can easily be adjusted to suit that particular level of light. ¤

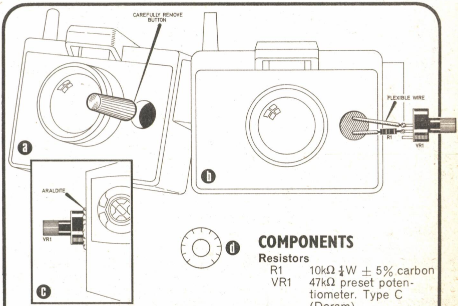


Fig. 1. Modification to the camera.
(a) Removing the light/dark button.
(b) Wiring in the potentiometer and resistor.
(c) Glueing the potentiometer in position.
(d) Suggested scaling for the new control.

COMPONENTS

Resistors

R1	10kΩ $\frac{1}{4}$W ± 5% carbon
VR1	47kΩ preset potentiometer. Type C (Doram)

Miscellaneous

Thin flexible wire; epoxy glue or similar; material for scale; solder.

Everyday News

TELEPHONE CHARGE CLOCK

Telephone users will now be able to see at a glance the cost of a telephone call, including VAT, in pounds and pence as it is accumulating. This has been made possible by the invention of a device called a Telephone Charge Clock, manufactured and marketed by Monitel Ltd, Dept EE, Berechurch Road, Colchester.

Two versions of the unit are available, the UK model (£29·00) and the International model (£39·00) which covers Europe, North America and the Caribbean. The International model can also be card-programmed to cater for telephone calls to Australia, South America and South East Asia.

The cost of a telephone call is dependent on several factors: duration of the call, distance of the call, the time of day and the day of the week. All of these parameters are under the control of a single chip microprocessor located in the unit that is programmed with tariff rates and VAT by a punched card inserted by the user. When any of these parameters are changed by the Post Office or Government a new punched card to update the system will be provided by Monitel for an annual fee of £1·50 (UK) and £2·00 (International).

The Monitel is so designed that it forms the base-pad of the telephone set (available in matching colours), but is in no way connected to the telephone itself, in accordance with the requirements of the Post Office. However, the device does need to be permanently plugged into the mains to maintain the card programme. If disconnected from the mains for any reason, the card must be re-inserted.

Equal Opportunity

Lady engineers are increasing in number, but very slowly. Of 190,000 chartered engineers registered in the UK only 200 are of the fair sex.

The lady intake is, however rising. Eight years ago at Cambridge University there were only four reading engineering. Today there are 42.

* * *

The secretary general of the ITU has forecast that there will be 1,200 million telephones in use in the world by the year 2000.

* * *

LEISURE CENTRES

Linking up on tape cassette systems to exploit the TV games market are General Instruments Microelectronics Ltd and EMI. The idea is to have a super TV leisure centre. Like a music centre but for video, incorporating a computer terminal on which all the family can involve themselves not only in TV games of advanced form but also in programmed learning with Teletext and Viewdata as options.

POP-CRAZY

Anyone who doubts the pulling power of pop music can now put the doubts aside. On present projections over a million calls will be made to the Post Office Dial-a-Disc service this year. The service is second only in popularity to the Speaking Clock.

* * *

A complete TV sound system on a single chip has been introduced by RCA. It includes a multi-stage i.f. amplifier—limiter, an f.m. detector and audio power amplifier which delivers 3W output to the loudspeaker.

* * *

SPACEWATCH

The Department of Industry and the Science Research Council have written to universities, research bodies and other interested organisations to point out that the European Space Agency (ESA) is seeking proposals for the *Spacelab* programme.

Experiments which are thought to be most suitable for the *Spacelab* programme are in the fields of material sciences and space processing, life sciences, space technology, atmospheric sciences, earth observations and geodesy, astronomy and astrophysics.

The cost of launching and other implementation costs of these *Spacelab* missions will be borne by the Governments of the relevant Member States. Experimenters will be expected to find the funds for their own preparatory work and the cost of manufacture of the experiment, but, of course, they can apply to be considered for financial support through normal Government and Research Council channels.

The United Kingdom has still to decide on its participation in these *Spacelab* missions. The interest shown by potential UK users will be one of the factors to be taken into account when a decision is made later this year.

Full details of the programme and information for applicants is contained in ESA's Preliminary Call for Experiment Proposals (PCEP). Requests for copies of this document and for further information should be addressed to Space (RTS 5) Branch, Department of Industry, Abell House, John Islip Street, London SW1.

FLORAL DANCE

At the recent "Festival for Mind and Body" (Olympia, London), house plants provided the musical background for one of the stands.

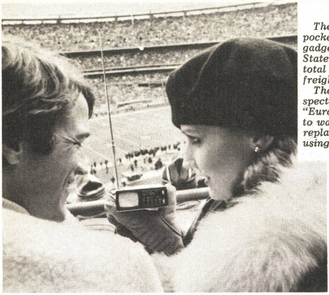
One stand had a greenhouse containing a variety of different plants and gardening equipmet; it was also wired for sound. A four-channel amplifier and speakers received input signals from a number of plant leaves via a Bio Activity Translator. This Translator generated musical notes which followed the increase and decrease of the plants bioelectrical potential, producing soft flute or bright brass-like sounds.

The Floral Orchestra, as it is called, attracted a lot of intrest, as did the light displays using coloured spotlights with inputs connected via a Bio light system to the leaves of other plants. The resulting effect was an attractive random sequence light show which could be altered by approaching the plant, talking to it or stroking it.

* * *

Britain's largest electrical/electronic group of companies, GEC now has 164 factories in the UK and 46 overseas. The company employs 156,000 people at home and 36,000 abroad.

. . . from the World of Electronics



HOT SHOT

The Sinclair Microvision pocket TV is selling well in gadget-conscious United States. Over 80 per cent of total production is air-freighted to US cities.

The latest craze is for spectators at American and "European" football matches to watch close-ups and action replays of live broadcasts using their pocket TV.

—ANALYSIS

OTHER PEOPLE — OTHER WORLDS

Twentieth Century space flight with all its technical brilliance has so far not proved that civilisations other than our own exist in the Universe. In fact, apart from our own teeming Earth, no signs of life are evident in our own solar system, even in very low forms.

A "local" search has provided negative results. But some researchers argue that if we widen our horizon to the galaxy in which we live, estimated to contain at least 250 billion stars, perhaps as many as 1,000 billion, it is conceivable that anything up to a million other civilisations may be alive and well.

So, for the past 18 years there have been various attempts to discover such civilisations, if they exist, by listening carefully for their radio signals. To date, none have been identified. Theorists who still believe there is life "out there" now think we have been listening in the wrong way, tuned to spot frequencies in the radio spectrum whereas it would have been better to look at whole blocks of frequencies simultaneously and analyse all the signals within a block for signs of intelligence as distinct from random noise which characterises most radio emissions from outer space.

Now a seven-year programme of SETI (Search for Extraterrestrial Intelligence) is proposed in the United States using techniques newly available and made possible by the microprocessor, large-scale memories, and low-noise radio receivers. The aerial systems will be the Deep Space array at Goldstone, California, and the Arecibo Radio Astronomy Observatory in Puerto Rico, both of exceptional collecting power. Heart of the signal processing system will be a spectrum analyser which will be able to scan a million radio channels simultaneously and indicate which, if any, contain intelligence.

The researchers hope to hear, for example, radio broadcast or TV signals which may have "leaked" into space rather than messages directed to us on earth. It is doubtful whether we could ever achieve two-way radio communication because if another civilisation exists, say, 1,000 light-years away, it would take 2,000 years to get a reply. Even if intelligence-bearing signals are discovered, they would, on the same basis, be 1,000 years old when received on earth. In fact just a little piece of history. Are you listening, Old Man?

Brian G. Peck

CLUB CORNER

The next gathering of the British Amateur Electronics Club will be at their annual Exhibition, at the Shelter, The Esplanade, Penarth, South Glamorgan, from June 15 to 22.

On view will be members constructional projects ranging from the advanced to very beginners circuits.

ELECTRONICS AIDS THE DEAF

During the National Deaf Childrens' Week (May 7-13) a *National Deaf Children's Society Exhibition and Seminar*, was held at Mullard House, London. It demonstrated (amongst other things) the many ways in which electronics is currently being used to help deaf children.

As well as the latest technological achievements in this field there was also a "historical" section where visitors could see how rapid the growth has been. For example, the first ever National Health hearing aid was produced in 1948, and was a very bulky affair, the batteries were larger than some of today's portable radios.

Diagnosing and treatment was the main theme of the exhibition, with one point being made quite clear: children should be screened at a very early age, preferably soon after they are born. For this, an aid developed by Brunel University called the Auditory Response Cradle was on demonstration. This device concentrated on measuring the impedence and efficiency of the ear of the newborn.

A further aid in diagnosing deficiences of the ear was the Tympanometer™, a simple to use device for identifying the presence of middle ear effusions, the result being electronically printed as a graph.

One of the major barriers for the deaf, particularly children, is learning to talk, and once again electronics can help in this way. One example was the Cambridge Single Sound Trainer developed by Cambridge University.

In this trainer, sounds entering a microphone are analysed by a computer, the shape of the sound then being displayed on an oscilloscope screen. Superimposed on the screen is the correct shape for that particular sound. The subject can thus improve his speech by successive attempts at matching the correct shape with his own.

Aimed at teaching basic skills in recognition to those who have difficulty in learning, the Possum™ was also on display.

ORACLE FOR THE DEAF

The Independent Broadcasting Authority (IBA) and the Independent Television Companies Association (ITCA) are jointly supporting a research project at Southampton University to help the deaf and partially deaf to benefit more fully from television programmes.

The work expected to cost over £50,000 is aimed at providing optional sub-titling for the deaf and hard of hearing by means of the ORACLE teletext system.

The project is to be carried out by a Research Fellow sponsored by the IBA-ITCA under the supervision of Dr. A. F. Newell at the University of Southampton.

The project, expected to take three years, will be to establish the form of sub-titling which would most benefit the deaf and hard of hearing. Equipment specially designed by ITCA will enable sub-titling of both recorded and "live" programme material.

The European Space Agency is spending £75 million on two European regional communication satellites and two maritime communications satellites.

Some 20 per cent in value of the contracts goes to British Aerospace Dynamics, leader of the European consortium which includes companies in France, Germany, Sweden, Italy and Spain.

LOGIC PROBE

By P.W. Bond

TTL integrated circuits are used widely in amateur electronics because of their low cost, robustness and the fact that they are versatile enough to allow quite elaborate circuitry to be made up within a limited space.

Now the trend seems to be for CMOS logic circuits, and these have various advantages and disadvantages compared with TTL. In the electronics industry, advances have been made which allow many more circuits to be put onto one silicon chip; a stage of very large scale integration has been reached where many thousands of logic elements can be available in a circuit.

Indeed, these special purpose i.c.s are sneaking onto the constructors work bench and it is possible for "complex" units such as TV games and digital clocks to be built very simply.

FAULT TRACING

However there are times when all that one requires is a simple logic gate which performs an operation such as a NAND or NOR or even a simple divide-by-two circuit. One can obtain TTL circuits which perform these functions for next to nothing.

At a recent radio exhibition, the author purchased a circuit board out of a defunct computer for £1 and found later that of the 50 i.c.s on the board, some 47 were in usable condition.

The Logic Probe described here not only allows testing of those reject i.c.s, but can be used to trace faults in some i.c. projects. The pocket-sized unit is self-powered, requires only one connection to the equipment being tested and checks that the logic level is above the operational limit.

CIRCUIT DESCRIPTION

Before the unit is described it is as well to look at the worse case conditions for the 74 series of i.c.s. The i.c. has a supply voltage that can lie between 4·75 and 5·25 volts.

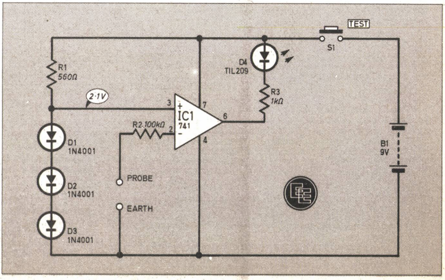
The logic "high" or "1" potential is between 2 and 5 volts approximately and the logic "0" level is between 0 and 0·8 volts.

In the simple circuit described here logic "1' is any level above about 2·1V. The logic "1" level is perhaps more important to look for in TTL circuits because of the inherent quality for disconnected inputs to "float" at the 5V supply potential.

REFERENCE VOLTAGE

Referring to Fig. 1 a reference voltage is generated by connecting three forward biased silicon diodes across the battery so that the voltage produced is three times that of a fully-conducting silicon

Fig. 1. Complete circuit diagram of the Logic Probe.



COMPONENTS

See **Shop Talk** page 547

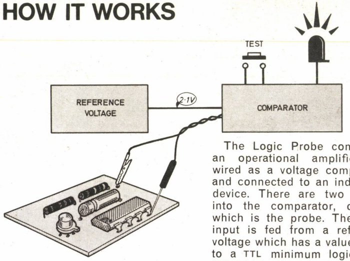
Resistors
R1 560Ω
R2 100kΩ
R3 1kΩ
All ¼W carbon ± 5%

Semiconductors
IC1 741 op amp 8 pin d.i.l.
D1, 2, 3 1N4001 (3 off)
D4 TIL209 red light emitting diode

Miscellaneous
B1 PP3 9V battery
S1 push-to-make, release-to-break miniature push switch
Stripboard 0·1 inch matrix 6 holes × 17 strips; Verocase 100 × 50 × 25mm; PP3 battery connector; socket for IC1; crocodile clip; stiff wire and plastic sleeving for probe; connecting wire; small grommet.

The following components are required only for testing; 1·5kΩ, 1·2kΩ, 6·8kΩ ¼W 5% resistors; 9V battery.

HOW IT WORKS



The Logic Probe comprises an operational amplifier i.c. wired as a voltage comparator and connected to an indicating device. There are two inputs into the comparator, one of which is the probe. The other input is fed from a reference voltage which has a value equal to a TTL minimum logic level "1". This voltage is about 2·1V.

When the TEST switch is operated, the reference voltage is compared with the input at the probe. If the probe is connected to a true logic "1" in the circuit under test, the comparator causes the indicator to illuminate. If on the other hand the probe is connected to a logic "0" then the indicator will not light. To obtain the required 2·1V reference voltage, three diodes are used connected in series, since the voltage drop across each diode is 0·7V.

diode; 3×0·7=2·1V, this is the low threshold of the TTL logic "1" voltage range.

A voltage comparator, IC1 is used to compare the voltage at the probe with the voltage from the diodes, and if this voltage is more positive than the reference then the l.e.d. is made to conduct and hence illuminate.

The i.c. is arranged with its non-inverting input, pin 3 connected to the reference and the inverting terminal pin 2 connected to the probe via resistor R2. By the action of the opamp the non-inverting input is always positive with respect to the inverting under idle conditions so that the output, pin 6 is almost +9V.

Now when the probe becomes positive by slightly more than 2·1V the non-inverting input is now taken negative with respect to the inverting input so the output swings negative to almost the 0V rail of the supply. The l.e.d. now illuminates.

The input impedance of the circuit is very high compared to the impedances around the TTL logic circuits so it in no way upsets the action of the circuit during examination.

The unit is self-powered so that the comparator action of the op-amp will work satisfactorily, and it also means that there is no need to rely on the equipment supply which itself could be out of the specified limits.

Because the circuit is very simple there is no need for elaborate construction and indeed if one wishes a different method of construction, this is perfectly acceptable with this circuit, providing of course, that you wire the unit together correctly.

START HERE FOR CONSTRUCTION

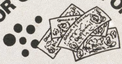
STRIPBOARD

In order to make the unit as small as possible, a shallow plastic case was used and the circuit was constructed to fit into it. It is for this reason that the circuit board takes the rather unusual shape of only 6 holes by 17 strips, so that the board can fit snugly into the slots of the case. There is a need to put certain components on the underside of the board and a need to wire the connecting leads to the relevent side of the board.

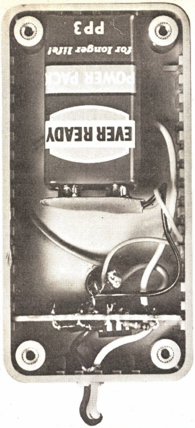
The board is shown in Fig. 3, and the components are mounted as indicated.

The wires to the probe can be any length, and 30cm seems a reasonable length to use. The case needs to be drilled to suit the components used, but bear in mind that space does not allow a bezel to be used for the l.e.d. or there will be difficulty in installing the battery. Instead half a small grommet is used and mounted on the outside of the case. This gives a neater finish than with the l.e.d. just mounted in the hole.

FOR GUIDANCE ONLY



ESTIMATED COST OF COMPONENTS
£1.50
excluding case



The board should be slotted into position after the probe leads have been pushed through their feed hole in the side of the case, and the remainder of the wiring carried out as shown in Fig. 2.

The wires for the l.e.d. should not be cut short bearing in mind that the shorter of the two is the negative anode connection and connects to the push button. It is advisable to place a small piece of insulating tape over the leads, thereby holding the leads close to the surface of the case. This also insures that the battery cannot short out the leads, causing incorrect results.

The case used in the prototype was sprayed with an aerosol paint but this is not essential and was for effect rather than purpose, but the case does need to be labelled and the push button and l.e.d. marked as shown in the photographs.

The earth connection to the equipment under test was made with a small crocodile clip, and the probe itself was made by taking a stiff piece of wire and cutting it to a length of about 8cm depending on the size required, and the probe lead connected to this. The wire must, of course, be tinned with solder beforehand or a good connection will not be achieved. To complete the probe a piece of sleeving was slipped over the probe and the connecting lead.

TESTING

To test the unit three resistors are required and these are connected across a 9V battery. What is produced is a simple potential divider giving voltages as shown in the circuit of Fig. 4. The earth connection is made to the probe unit from the negative terminal of the battery and the results should comply with those shown.

If these results are not obtained then the unit should be checked for wiring errors etc. Bear in mind when testing that the voltages shown are subject to component

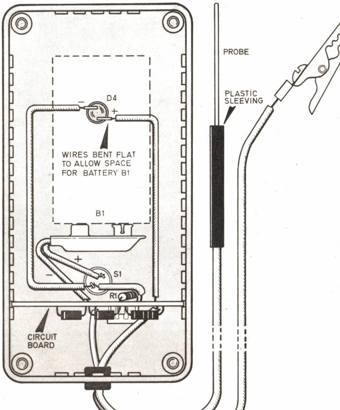


Fig. 2. Remainder of the wiring and construction of the probe. It is advisable to place a small piece of sticky tape over the wires of D4.

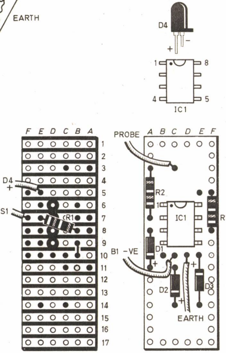


Fig. 3. Stripboard layout. Note that R1 is mounted on the underside of the board. There are only four breaks to be made under the i.c.

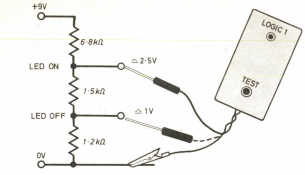
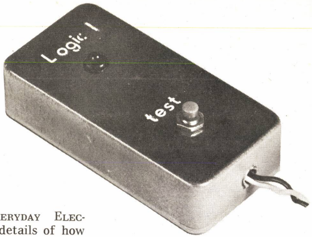


Fig. 4. Testing the Logic Probe using a potential divider to define the two logic levels. In this test we are only concerned with the "high" logic function of the Probe.



tolerances. The test is only to ensure that the probe operates on logic levels of "1" and no other levels in between.

The unit will be most useful in fault finding in slow speed pulse circuits and on circuits which employ simple gates. Although there is not room to list the many methods of fault location here, there have been some articles in past isues of Everyday Electronics which give details of how the various logic elements function. Remember though, projects found to be faulty are rarely the designer's fault, it is normally a fault in the construction, so take time to check wiring thoroughly.

To make a test on a circuit the earth lead is connected to the 0V supply of the equipment to be tested and the probe is touched to the point in the circuit whilst the pushbutton is depressed. If the level is a true logic "1" then the l.e.d. will illuminate otherwise a "low" condition, or the indeterminate state between 0·8 and 2V, will be indicated. ⌑

BOOK REVIEWS

THE SECRET WAR

Author Brian Johnson
Price £6·50
Size 250 × 180mm 352 pages
Publisher BBC
ISBN 0 563 17425 0

This book is based on the BBC Television Series of the same name. It provides a fine "hard copy" record of the exciting story told in the 1977 television production. Many excellent photographs, often unique, and all of historical interest, accompanying the text. It is a well-researched account, with considerable technical detail, of some of the many activities, then highly secret, that were engaged in by, or on behalf of, the armed forces operating on land, sea and in the air during the Second World War.

Much of the "Secret War" was related to electronics—although the word had not then entered into general use. The "ether" became a principal battle ground, with the protagonists striving relentlessly to keep one step ahead, or to speedily surmount the ingenious but menacing inventions of the other side. This hard-fought war by scientists and technical personnel of the Services became essentially a battle of the frequencies. Demands for improved radar and counter measures forced along development into the comparatively unexplored upper regions of the radio wave spectrum—from short waves to centimetric waves. Great technical achievements in a few short years were the outcome of this "war".

The account of the breaking of the code used by the German army and air force provides a dramatic concluding chapter to this book. Apart from its sensational revelations (with more than a hint that these activities also brought forth the first truly electronic computer) this triumph of British code breakers is of course the most recently released secret relating to the 1939-1945 war. Fascinating reading, but the whole truth on "Enigma" has yet to be revealed. There remain obvious gaps in the story—how did enemy wireless traffic appear on the cryptanalysts' desks? Not by magic. Another story involving humble "Wireless-ops" is waiting to be told. F.E.B.

STARTING AND RUNNING A SMALL BUSINESS

Author Alan Sproxton
Price £3·95
Size 210 × 130mm 130 pages
Publisher United Writers Publications
ISBN 901 976 40 7

Be your own boss. The dream occurs to all, but few take the plunge. It is considerably easier if you have someone to turn to who has already succeeded in such a venture, for there is nothing to beat experience.

In this informative and most entertaining book, the author sets out to smooth the path for the would-be small business proprietor. In particular Mr. Sproxton is writing about starting and running a retail business. His trade happens to be electronic components so his experiences gained over more than 30 years well equip him to offer guidance to others. His book is worth the serious attention of any Everyday Electronics reader who is thinking of "changing sides of the counter". The component business provides many examples of the successful small trader. It seems that one really can combine business with pleasure. F.E.B.

For your ENTERTAINMENT

By ADRIAN HOPE

Hall Effect

Watch out for a whole new generation of magnetic recording heads in the not too distant future. The Japanese Company Hitachi has already produced machines with Hall effects heads and it's a safe bet they'll be on the European market within a matter of months.

The Hall effect is actually nearly 100 years old. In simple terms if you take a strip of metal, pass an electric current through it and then apply a magnetic field, the current flow will be diverted sideways.

The amount of current diverted varies with the strength of the magnetic field. If the current is flowing through a semiconductor rather than a metal then the effect becomes much more noticeable.

Modern magnetic flux meters rely on the Hall effect, a small strip of semiconductor being secured on the end of a pointed probe. It's clearly logical to use the Hall effect when making a playback head for a tape recorder but until now engineers have found it difficult to produce a Hall effect head which is an improvement over an ordinary induction head. One problem has been poor signal-noise ratio.

Now Hitachi have a string of patents all around the world covering their Hall effect head which is claimed to perform with less distortion and noise than conventional heads.

It also offers the possibility of making the tape recorder playback head very small which is a useful bonus for designers of stereo cassette decks.

Another interesting aspect of the Hall effect head is that its output is not dependent on the speed at which the tape is travelling. This could enable designers to simplify the complex replay equalisation currently needed for tape at different running speeds, for instance $1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$, 15 inches per second and so on.

Perhaps even more interesting is the fact that a Hall effect head will still produce a signal even when the tape is stationery. The signal will, of course, be d.c. only but it should be easy to build in circuitry which will produce some kind of audible sound from even stationary tape and so enable much more precise editing than at present. With an ordinary induction head, the tape produces no sound whatsoever when stationary and to find an editing point, for instance silence between sounds, the tape must be rocked backwards and forwards past the head.

Effective Resistance

While Hitachi in Japan works on the Hall effect, Philips of Holland are working on a magneto-resistance effect head. Again, the idea is around a century old but is only just at a point of successful adaptation to tape recording.

A strip of ferromagnetic alloy is used as the head and its resistance continually read by a measuring current. As the magnetic tape passes beneath the alloy strip, its changing magnetic field produces corresponding changes in its overall resistance and current flow. These changes are easily converted into audio, just as the diverted current flow in a Hall effect head produces audio.

As with the Hall effect head, the Philips head can be made very small. Also like the Hall head it should be less dependent on tape speed and so require less sophisticated replay equalisation. It should also be able to produce an audible signal even when the tape is stationary.

It seems likely that as soon as Hall or resistance effect heads are available to tape recorder manufacturers, no one will want to use the traditional and comparatively clumsy types of induction head.

All Charged Up

For years now I have watched with bemused interest while a whole new industry has grown out of record cleaning and static elimination. There are now literally hundreds of gadgets on the market intended to clean a record and either to prevent the formation of, or dispel, static electricity. The sad truth is that very few of these gadgets work reliably but an understanding of the basic scientific principles is all you need to make up your own mind over what is worth buying and what is not.

In the meantime, here is a delightfully easy way to show how some record cleaning devices could equally well be sold as static generators! It is also a delightful party trick with which to impress your friends.

Assuming you live in a dry, non-humid atmosphere, e.g. a centrally heated home and thus are prone to static, take an ordinary gramophone record and lay it on top of a polystyrene box. The box will act as an insulator. Take a dry record cleaner (or a piece of fluffy fur cloth) and polish the record.

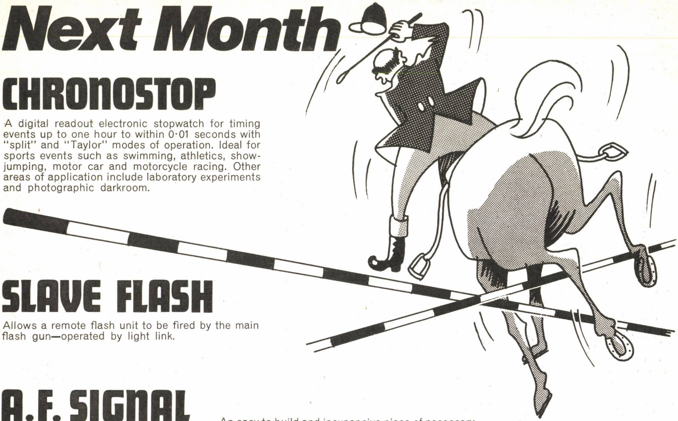
Now take a flat metal plate, around the size of an ordinary gramophone record, but with an insulated handle. (Half a large metal tape spool with a plastic handle glued to the centre is ideal.) Holding the metal plate by its plastic handle touch it lightly flat onto the surface of the record you have just polished. Any static charge from the disc will now induce a similar charge on the metal plate.

With one hand hold the now charged metal plate aloft and with the other hand pick up a small domestic fluorescent tube, touching one of its two electrical contacts. Now touch the metal disc with the other terminal of the tube so that the charge on the metal plate can escape to earth via the tube and your body.

If the disc was charged by your polishing then the charge induced on the plate by the disc will cause a dramatic flash of light as it runs off down to earth through the fluorescent tube. You can repeat the trick without repolishing and recharging the disc—just touch the metal plate on the disc again and release the induced charge through the tube.

I make no claims to originality for this very impressive demonstration of how many record cleaning gadgets induce static in records, and thus positively encourage them to get dirty again by attracting dust from the air. I first saw the trick performed at a technical seminar run in London by Shure, the American manufacturers of high quality gramophone pick-up cartridges. Shure in turn make no claim to originality and point out that Alessandro Volta was doing something very similar well over 100 years ago.

Next Month



CHRONOSTOP

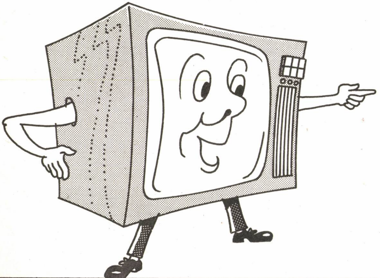
A digital readout electronic stopwatch for timing events up to one hour to within 0·01 seconds with "split" and "Taylor" modes of operation. Ideal for sports events such as swimming, athletics, show-jumping, motor car and motorcycle racing. Other areas of application include laboratory experiments and photographic darkroom.

SLAVE FLASH

Allows a remote flash unit to be fired by the main flash gun—operated by light link.

A.F. SIGNAL GENERATOR

An easy to build and inexpensive piece of necessary equipment for the workshop. Will provide a sine-wave output at frequencies up to 15 kilohertz in three ranges.



T.V. GAMES

BEHIND THE SCREENS —HOW THEY WORK

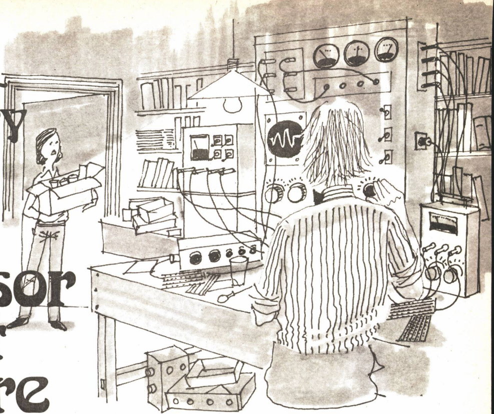
A short series dealing with a rapidly expanding field of consumer electronics. Starting with a history of TV Games, and basic principles of TV character generation, these articles will explain how earlier games and the more complex current games work, and will demonstrate a method for enhancing character forms involving a practical application of logic design and programming.

Part–1 appears Next Month.

Everyday ELECTRONICS

AUGUST
ISSUE ON SALE
FRIDAY, JULY 21

The Extraordinary Experiments of Professor Ernest Eversure



by Anthony John Bassett

LAST month the Prof. had discussed, with Bob, insulation breakdown in output transformers of valve amplifiers due to high voltage surges.

As the Prof. finished his diagram showing the output stage of the Vox AC-30 amplifier (Fig. 1), one of his experimental robots returned with the partly dismantled output transformer. Bob and the Prof. could see that part of the transformer insulation was badly charred and the wires blackened by the carbon which had been produced by the effect of the heat. As the Robot departed to continue with the repair of the transformer, their attention returned to the diagram.

VALVES IN PARALLEL

"The four output valves type EL84 are connected in two pairs, V3 V5; and V4 V6 so that in each pair the two valves work together to give double the output power which would be available from a single EL84 valve. In each pair the anodes are connected together, so that the anode currents of the two valves combine to flow through one half of the primary of the output transformer. This gives an effect similar to two larger valves in push-pull but with greater power, and is known as parallel-connected push-pull output stage".

"Prof., is it possible to connect more than two valves together like this to provide even greater power?"

"Yes Bob, for instance, in some amplifiers three or even more output valves have their anodes connected together, to drive one half of the output transformer primary, with an equal number of valves driving the other half. By this means, valve amplifiers can be built which will deliver enormous power; hundreds or even thousands of audio watts!

Then if a fault condition develops in the load, such as an open-circuit speech coil in a loudspeaker, or a loose connecting lead, this output power is prevented from reaching the load.

Now, this energy exists within the amplifier and according to the Law of Conservation of energy—it does not simply disappear! It exists in the form of a magnetic field in the core of the output transformer, and this field is generated and maintained by the current flowing through one half of the primary of the output transformer into the anodes of the output valves connected to it.

As the drive to the valves changes, the current is no longer maintained and the magnetic field collapses. But, then the energy which would normally have been delivered to the load produces a high-voltage spike, which can cause a breakdown of the insulation in the output transformer or the valve base. Another phenomenon which may sometimes occur, especially in valves with a poor vacuum, is flashover as the high voltage produces sparks inside the valve.

This is often harmless, but may be a warning of a leak of air into the valve. So it is often advisable to replace a valve in which sparks are observed".

"Prof., last month you mentioned a way to protect the valve bases from carbonisation, by replacing the plastic valve bases with ceramic ones. But I have not yet heard of a ceramic audio output transformer! What can be done to protect the transformer itself from these voltage spikes?"

PROTECTION CAPACITORS

The Prof. drew in a couple of extra components on the diagram (shown dotted, Fig. 1). They are both 0·001μF capacitors rated at 1000 volts working, each connected across one half of the primary winding of the output transformer.

"This is a simple and inexpensive method of protecting the transformer by use of paper and foil or 'MDC' capacitors of low capacitance and high working voltages. Now instead of doing damage to the output transformer the high voltage spikes, which may be present in conditions of fault or severe overload, will cause one of the capacitors to break down.

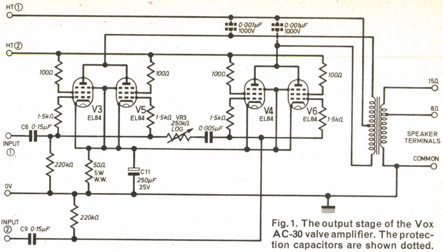


Fig. 1. The output stage of the Vox AC-30 valve amplifier. The protection capacitors are shown dotted.

COLOURATION

When this happens, the output power available from the amplifier is drastically reduced, but instead of the expense of a new output-transformer, all one needs is a replacement capacitor which costs a few pence! It is also possible to use capacitors of higher value such as 0·01μF 1000V, or even higher capacitance, and this will cause the transformer to resonate at particular audio frequencies giving "sound colouration" effects which are liked by some guitarists.

The "colouration" effects can be altered by changing the valves of the capacitors, but the rating of around 1000 volts should be observed, so that the output transformer is protected. If you use capacitors of a much lower working voltage they will break down too easily, and capacitors of a much higher working voltage might not break down in time to protect the transformer".

"Prof., I can see how the capacitors can protect the output transformer, but doesn't this mean that when a high voltage spike causes the capacitor to break down, it will become short-circuit and cause a large drop in volume? This would be embarrassing if it happened in front of an audience".

EXCESSIVE CURRENT

"Quite right, Bob, and I have another circuit which will absorb the energy from the spikes without any interruption to the performance. I will explain it to you, but first I would like to mention another likely cause of damage to the output transformer. This is excessive current flow, which, due to resistive heating of the copper wire, can also cause the transformer to fail.

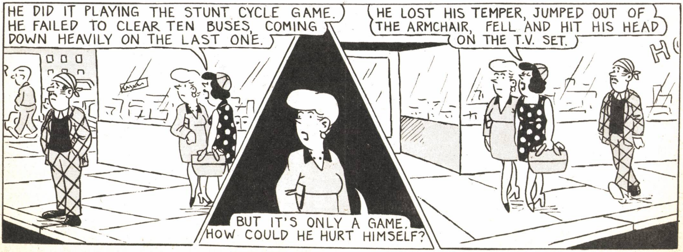
One component which may sometimes break down and allow an excessive flow of current through the valves and transformer is the cathode decoupling capacitor C11, to which the cathodes of all four of the output valves are connected. I will show you an alternative circuit which avoids this condition, and also offers a number of other worthwhile advantages".

The Prof. began to draw out a circuit for modification of the output stage of the AC-30 amplifier, and soon Bob could see this modification could easily be adapted to improve the output of many other types of valve amplifiers.

To be continued

JACK PLUG & FAMILY...

BY DOUG BAKER


HE DID IT PLAYING THE STUNT CYCLE GAME. HE FAILED TO CLEAR TEN BUSES, COMING DOWN HEAVILY ON THE LAST ONE.
BUT IT'S ONLY A GAME. HOW COULD HE HURT HIMSELF?
HE LOST HIS TEMPER, JUMPED OUT OF THE ARMCHAIR, FELL AND HIT HIS HEAD ON THE T.V. SET.

GEORGE HYLTON

brings it down to earth

Analogue or digital?

A READER ASKS: "Now that instruments are *going digital* can you tell me whether digital displays have any real value or are they just a passing fashion?"

An interesting question. I fancy that I can detect in it a hint of hostility to digital displays. This is understandable when you see somebody trying to tell the time outdoors in strong sunlight on one of those digital watches with red light emitting diode displays.

Sunlight makes it very hard to see the illuminated figures so the user of the watch cups his hand over it to cast a shadow, then peers into it to see the time—remembering, of course, to press the button which makes the figures light up.

Digital Time

Here is a case, surely, where a digital display is just too cumbersome to use easily. An old-fashioned dial with pointers would be simpler. But this one case of an inconvenient digital display doesn't prove that all digital displays on watches are bad.

A liquid crystal type of display, for example, can be seen in strong light and doesn't need a button pressed. To see what the real pros and cons of digital displays are we must forget the imperfections of particular displays and look at the principles.

In the case of watches there is another aspect to the question; the economic aspect. Digital watches, at least those with quartz crystals as the master timing element, can give very great precision and at a very reasonable price. They also have no moving parts to wear out, so apart from replacing the battery running costs should be negligible. None of those periodic visits to the watch repairer for cleaning or maintenance work.

However the economic aspect is not, I think, what our reader meant, when he asked whether digital displays have any real value. He meant value in themselves, as displays? And do they have any advantages over analogue displays?

Like so many apparently simple questions this one turns out to be rather complicated. Value to whom? And in what circumstances? Keeping to watches for the time being the obvious advantage of a digital display is that it is very clear and therefore unlikely to be misread. If your watch says 22.47 then that's it, upside down or sideways on.

This is more than can be said for the traditional watch faces, especially when the designer leaves off numbers as he so often does.

The other obvious advantage is that the digital display makes full use of the inherent accuracy of the quartz crystal, by indicating the time to the very second in an easily read and unambiguous fashion.

The traditional watch requires three pointers to do this and three pointers are one too many for easy reading.

Clock Watching

The limitations of digital time displays become apparent when instead of just telling the time you have to "watch the clock" in order to keep an appointment, catch a train, bake a cake or whatever. With the old fashioned analogue dial you begin clock watching with one piece of mental arithmetic. You work out where the hands will be at the appointed time and make a mental note of that. From then on a quick glance at the dial gives an instant impression of how much time you have left.

Not a precise impression but quite good enough for the purpose in hand.

Creepy Hands

You can't do this with a digital time display. At any rate, I can't. It could just be that I'm so unaccustomed to digital clocks and watches that I just haven't learned to use them with the same ease as pointers but with a few years practice I could do so. But I doubt it. You don't find many digital clocks in places where people must keep a very careful eye on the time so as not to over-run some appointed period.

A good example is a broadcasting studio, where the producer knows his programme must end at a particular moment to make way for the next, which is ready and waiting in another studio. For the producer it is a lot easier to watch the hands creep towards the appointed time than to do the mental arithmetic necessary to work out, from a digital clock, how much time there is left.

Producers have a lot to think about without doing this sort of mental task as well and for this reason they prefer a clock which tells you the way time is running out without arithmetic.

So I suspect that the difficulty of using digital clocks in this way is a genuine human problem (a psychological problem in the general non-clinical sense) and not just the result of the lack of familiarity. In circumstances where the sort of clock-watching I've been talking about must be done with very great precision you find that people do use digital clocks but to make them easier to use they arrange for them to run backwards down to the appointed moment.

The classic example is the count-down to a rocket launch or some other critical event.

Comparisons

I've been going on about clocks rather than meters because most of us are at the moment more familiar with digital clocks than with digital meters. But there are many meter-reading situations which are comparable to the time-telling and clock-watching situations just described.

It turns out that, with meters as with clocks, both types of display—digital and analogue—have their uses. Digital is excellent for making precise readings of steady voltages, currents, etc. Analogue, the old-fashioned pointer instrument, is good for watching quantities which are slowly changing.

Many of the measurements required in electronics are measurements of changing voltages or currents. If for example you are aligning a radio you will very likely do so by applying a modulated r.f. signal and adjusting the tuned circuits to obtain the maximum audio output (or the maximum a.g.c. voltage, which amounts to the same thing).

A pointer meter, measuring the output, shows which way it varies as you make the adjustments. It monitors a slowly changing quantity.

Accuracy

For very precise measurements digital instruments have a clear advantage. It is a good pointer instrument which can indicate to within one per cent of the true value and a good eye which can read it so precisely. But a digital meter can, if it has the right accuracy built into it, both indicate to within a tenth of one per cent and be easy to read at the same time.

If you are on the lookout for very small changes in some quite large quantity then a digital instrument wins hands down. The extreme case is the digital frequency meter. Some of these can indicate hundreds or even

TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO. LTD.
PHONE 01-672 3137/672 9080
MANUFACTURERS OF QUALITY AMPLIFICATION AND LIGHTING CONTROL SYSTEMS

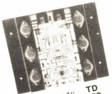
PRICES INCLUDE VAT. P & P FREE
correct at 1. 6. 78
TO ORDER BY POST

Make cheques/P.O.s payable to TUAC LTD. (EE78) or quote Access/Barclaycard No. and post to TUAC LTD. (EE78) 119 Charimont Road, London SW17 9AB. We accept phone orders from Access/Barclaycard Holders. Phone 01-672 9080.

NEW FROM TUAC

ULTRA QUALITY HIGH POWER

New D.C. Coupled Design AMPLIFIERS



7" x 9" x 1¾" TD 500

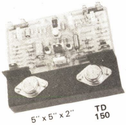
Featuring
Electronic Short Open & Thermal Overload Protection.

Brief Spec.
Input Sensitivity 0.775.v. R.M.S. (O.D.B.) at 25 K Ohms
Frequency Response 20 Hz-20 KHz
Hum & Noise – 100 dB Relative full output

T.H.D. at full powr 0.1%	
T.D. 500 300W into 2 Ohms	
220W into 4 Ohms	
Size 7" x 9" x 1¾" 140W into 8 Ohms	**£45.00**
Power supply P.S. 300	**£28.50**
T.D. 150 150W into 4 Ohms	
5" x 5" x 2" 100W into 8 Ohms	£26 25
Power supply P.S. 150	**£17.75**
T.D. 150. 60 Version 60W into 8 Ohms	£17.75
5" x 5" x 2" 40W into 15 Ohms. Power supplies P.S. 60	**£15.25**

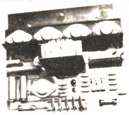
Note P.S. 300 will drive 2 T.D. 150 amplifiers

All output ratings are R.M.S. continuous sine wave output.



5" x 5" x 2" TD 150

AMPLIFIER MODULES



SPEC. INPUT SENSITIVITY 60 mV for full output
Frequency response 20 Hz-20 KHz
HUM & NOISE – 70 dB

TL60 5 × 5 × 3in
- 60 watt R.M.S. continuous sine wave output
- 2 R.C.A. 110 watt 15 amp transistors

£18.25

TL100 5 × 5 × 3in
- 100 watt R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp transistors

£20.75

TP125 7 × 6½ × 3in
- 125 watt R.M.S. continuous sine wave output
- 4 R.C.A. 150 watt 15 amp output transistors

£25.75

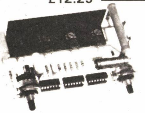
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER – 4LSMI

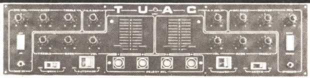
- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully supressed and fused
- Switched master control for sound operation from ½W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£20.75

Model 501 500W per channel as above without sound triggering

£12.25





STEREO DISCO MIXER

With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble and bass controls for each pair of sliders. Sensitivity mag., 3mV (R.I.A.A. comp.). Flat 50mV at 1kHz. Bass controls ± 18dB at 60Hz. Treble controls ±18dB at 15kHz.

OUTPUT: Up to 3 volts (+ 12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz – 25kHz ± dB.

P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.

Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switches. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions *Size:* 25in long × 6in high × 3in deep.

£129.00

Mono Disco Mixer with autofade **£45.00**

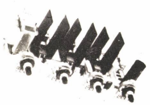
3 CHANNEL LIGHT MODULATOR SILMB

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

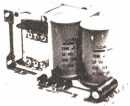
£20.25

Single Channel Version 1500 Watts

£9.75



POWER SUPPLIES



Vacuum varnish impregnated. Transformers with supply board incorporating pre-amp supply:

PS250 for supplying 2 TP125s	£28.50
PS200 for supplying to TL100s	£28.50
PS60/60 for supplying 2 TL60s	£25.00
PS125 ±45 volts for TP125	£17.75
PS100 ±43 volts for TL100	£16.25
PS60 ±38 volts for TL60	£15.25
PSU 2 for supplying disco mixer	£7.50

PIEZO SUPER HORN ONLY £8.50

STOCKISTS – CALLERS ONLY

A1 Music, 88, Oxford Street, Manchester (Tel 061-236 0340)
Geo Mathews, 85/87, Hurst Street, Birmingham (Tel 021-622 1941)
Soccodi, 9, The Friars (Tel Canterbury 60948)
Cookies Disco Centre, 126/128, West Street (Tel Crewe 4739)
Garland Bros. Ltd., Deptford Broadway, London 01-692 4412
Luton Disco Centre, 88, Wellington Street, Luton (Tel Luton 411733)
Session Music, 163, Mitcham Road, Tooting (Tel 01-672 3413).
Mon-Sat 10am to 6pm. Closed Wed.

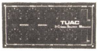
FRONT PANEL FOR LIGHTING EFFECT MODULES

(complete with switches, neons and knobs) as illustrated

For S1LMB **£6.50**
Size 8" x 4½"

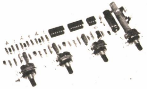
4LSM1 **£5.50**
Size 6½" x 4½"

FUZZ LIGHTS
Red, Green, Blue, Amber. **£23.50**



S1LMB **£7.50**
Combined with 3SDM1
Size 9" × 4½"

ADD SEQUENCE CHASING + DIMMING EFFECTS FOR TUAC 3 CHANNEL LIGHT MODULATOR

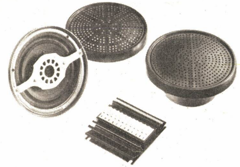


- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel

3SDMI **£14.50**

SUPPLIERS TO H.M. GOVT. DEPTS. MANUFACTURED AND ASSEMBLED IN GT. BRITAIN FULLY TESTED AND GUARANTEED
SEND NOW FOR OUR FREE 28 PAGE ILLUSTRATED CATALOGUE. SEND STAMP PLEASE

THE DYNAMIC DUO



The C15/15 is a unique Power Amplifier providing Stereo 15 watts per channel or 30 watts Mono and can be used with any car radio/tape unit. It is simply wired in series with the existing speaking leads and in conjunction with our speakers S15 produces a system of incredible performance.

A novel feature is that the amplifier is automatically switched on or off by sensing the power line of the radio/tape unit, hence alleviating the need for an on/off switch.

The amplifier is sealed into an integral heatsink and is terminated by screw connectors making installation a very easy process.

The S15 has been specially designed for car use and produces performance equal to domestic speakers yet retaining high power handling and compact size.

C15/15
15 watts per channel into 4Ω
Distortion 0·2% at 1 kHz at 15 watts
Frequency Response 50Hz-30kHz
Input Impedance 8Ω nominal
Input Sensitivity 2 volts R.M.S. for 15 watts output
Power Line 10-18 volts
Open and Short Circuit Protection
Thermal Protection
Size 4 × 4 × 1 inches
C15/15 Price £17·74+£2·21 VAT P&P free

Data on S15
6″ Diameter
5¼″ Air Suspension
2″ Active Tweeter
20oz Ceramic Magnet
15 watts R.M.S. Handling
50Hz-15kHz Frequency Response
4Ω Impedance
S15 Price per pair £17·74+£2·21 VAT P&P free

TWO YEARS GUARANTEE ON ALL OF OUR PRODUCTS

Please supply ....

Total Purchase Price ....

I enclose cheque ☐ *Postal Order* ☐ *Money Order* ☐ *Please debit my Access Account* ☐ *Barclaycard Account* ☐

Account Number ....

Name & Address ....

....

Signature...

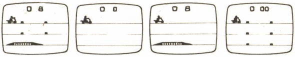
Reg. No. 202141535

OLP ELECTRONICS LTD

Crossland House,
Nackington,
Canterbury, Kent
Tel (0227) 63218

ALL THE PARTS YOU NEED TO BUILD THE
STUNT CYCLE PROJECT
THE MOST COMPULSIVE TV GAME EVER MADE

★ Realistic stunt-cycle sounds come directly from the TV ★ Realistic crash effects and penalty points. ★ Four competitive games with amateur and professional modes. ★ On-screen scoring ★ Up to 36 buses can be jumped. ★ Throttle has the 'feel' of a motorbike: too much and you will skid and crash, too little and you will not get over the buses or obstacles.



Super Stunt Cycle Drag Race Stunt Cylce Motocross

AY-3-8760-1 **£11·90**
P.C.B. (EE Project copyright Teleplay) **£2·50**
STYLISH CASE **£2·50**
SOUND & VISION MODULATORS **£4·90**
100uH CHOKE **0·45p**
BASIC KIT (All PCB Components) **£18·90**
COMPLETE KIT (No Extras needed) **£25·90**

VERY
EASY
ASSEMBLY
SUITABLE
FOR FIRST
TIMERS

+ FREE
MAINS ADAPTOR

All prices include VAT. For orders under £10 add 20p p&p. Cheques and postal orders to be made payable to TELEPLAY; send your order (no stamp needed), to: **Teleplay, Freepost, Barnet, EN5 2BR,** or telephone your order quoting your Barclaycard or Access number.

BARCLAYCARD VISA

SHOP OPEN 10 a.m.–7 p.m., Monday to Saturday
CLOSE TO NEW BARNET BR STATION—
MOORGATE LINE. Trade enquiries welcome.

Buy it with Access

41 STATION ROAD,
NEW BARNET, HERTS.
EN5 1QW
Tel: 01-440 7033/01-441 2922

teleplay

ANNOUNCING
A NEW SET
OF BASIC
ELECTRONICS

This 5 volume set contains over 500 pages. Bound in stiff linen. Cover size 8½in x 5in. Price £7.50 per set (we pay the postage).

Book 1. Introducing Electronics
Book 2. Resistors/Capacitors
Book 3. Inductors/Diodes
Book 4. Meters/Voltage-dividers
Book 5. Transistor Project Circuitry

The manuals are unquestionaby the finest and most up-to-date available and represent exceptional value.
This series has been written in a fascinating, absorbing and exciting way, providing an approach to acquiring knowledge that is a very enjoyable experience. Suitable for industrial trainees, City and Guilds students, DIY enthusiasts and readers of electronic journals.
Each part explains electronics in an easy-to-follow way, and contains numerous diagrams and half tone blocks with construction details and circuit diagrams for making the following transistor projects: Lamp Flasher, Metronome, Wailer, Photographic/Monostable Timer, Metal Locator, Geiger Counter, Radio Receiver, Intercom., Intruder Alarm, Electronic Organ, Battery Eliminator, Anemometer, Sound Switch, Light and Water-operated Switches, Pressure-operated Switches, Light meter, Radio Thermometer, Ice Alarm,

Order now:
Selray Book Company
60 Hayes Hill
Bromley
BR2 7HP

OUR 100% GUARANTEE
Should you decide to return the set after 10 days examination, your money will be refunded by return of post.

Amount enclosed: £ ____________________
Name: ____________________
Address: ____________________
EE7

thousands of megahertz down to the last hertz.

Note, however that they need time to do it. To count the number of cycles of oscillation in one second (which is what frequency is) calls for one second's counting. You can attempt to shorten the time by counting for only a thousandth of a second, say, but then the answer can only be reliable to the nearest kilohertz.

It is when you have to use a digital meter for an analogue job that life gets a bit tedious. There are times when it cannot be avoided.

For example, I'm doing some work, at the moment, on an oscillator whose frequency is changed very slightly when something is placed near its tuning coil. It happens to be of great interest to me to know whether the frequency then goes up or down. I don't care how much the frequency changes but I do need to know the direction of the change.

A pointer instrument would be ideal, if the changes were big enough to be visible as a pointer movement. But they aren't, so I have to use a digital meter. This means making a note of the present frequency, putting something near the coil, waiting two seconds to get a reliable reading, then comparing it with the original reading. This calls for remembering, waiting, and mental arithmetic.

How much simpler it would be just to watch a pointer.

Dual Displays

Dual displays, showing quantities in both digital and analogue form are possible and would clearly give the user the choice of picking whatever was more convenient. One trick is to present what is really digital information in an analogue form.

Imagine a long line of l.e.ds, connected to a voltmeter. When the input is 1 volt the first l.e.d. lights; at 2 volts the first two light; at 3 volts the first three and so on. As the voltage increases the line of light elongates like the fluid in a thermometer as it warms up. Such a display, alongside the numerical digital readout gives the user the best of both worlds.

Crossword No. 5—Solution

W	O	W	A	N	D	F	L	U	T	T	E	R	■	F
O	■	■	■	O	■	E	■	■	A	■	■	E	R	R
O	■	P	■	R	■	R	■	■	P	■	■	A	■	A
F	I	L	A	M	E	N	T	■	E	N	E	R	G	Y
E	■	A	■	S	■	■	H	■	■	■	■	■	■	E
R	A	T	E	■	■	■	Y	A	G	I	■	D	U	D
■	■	E	■	■	S	■	R	■	U	■	■	■	S	■
B	A	S	E	■	O	N	I	O	N	■	O	P	E	N
■	C	■	■	■	D	■	S	■	S	■	■	A	■	■
L	E	D	■	W	A	T	T	■	■	■	P	R	O	T
I	■	■	■	■	■	■	O	■	■	S	■	A	■	U
Q	U	A	R	T	Z	■	R	E	C	O	R	D	E	R
U	■	R	■	■	E	■	■	A	■	N	■	E	■	N
I	C	E	■	■	R	■	■	S	■	I	■	■	■	O
D	■	A	U	T	O	M	A	T	I	C	G	A	I	N

COUNTER INTELLIGENCE

By PAUL YOUNG

IN 1951 when I first made a definite step away from radio and television into component retailing, it is safe to say that electronic components were 100 per cent British made. Capacitors by Mullard, Dubilier and T.C.C. Resistors by Erie and the Morgan Crucible Company. Valves by Marconi and Osram. Speakers by Rola, Celestion and Whiteley. Meters by Avo and Ferranti. Transformers by Partridge and Parmeko. The list is endless! Contrast this then with the picture today—it is a depressing one.

I would hazard a guess that over 60 per cent of components are now imported, something that is frowned upon by Government, whatever its colour, and although I can claim to be as patriotic as my neighbour, I have literally been forced to buy my components from abroad, first on account of prices and secondly because the required items were no longer available in Britain.

Around the World

Take resistors for example. With a long experience in this field, I should be able to beat anyone both in quality and price, but in my search for a good product at a reasonable price I have had to go to France, Spain, Yugoslavia, Pakistan and Russia. When it comes to meters, microphones, switches, earphones, panel lamps and connectors, no one can approach the Japanese at present.

Optimistic

However, to end on a more optimistic note, we are better served with semiconductor devices by British makers, and one other field in which we obviously excel is variable capacitors. Jackson Brothers and Cyldon lead the way in this respect. Some months ago I asked a director of Messrs. Jackson whether they were ever bothered at the thought of a big influx of Japanese tuning capacitors? He laughed, and said "not while we are exporting them in large quantities to Japan"

Although not strictly components as such, it would be invidious not to mention Clive Sinclair, the man who sold three-quarters of a million pounds worth of pocket electronic calculators to Japan, which is almost the equivalent of selling snow to the Eskimos

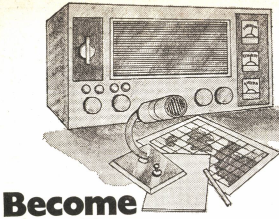
A Speed Problem

From time to time I like to give my readers a little puzzle to solve (especially if I don't know the answer myself). A short while ago I was asked to write an article on electronics for an educational journal and I wanted to mention in passing the speed of electricity in an ordinary closed circuit. I suddenly realised that I didn't know what the speed of electricity is.

I then remembered that many years ago there was a very knowledgeable and amusing writer in *Wireless World* whose weekly column was entitled "Unbiased" and whose nom de plume was "Free Grid". He made the point that when he put this question of the speed of electricity to a number of senior electrical engineers, they all made the same error by stating that it was the same as the speed of light. Not so—it is considerably slower.

Do You Know?

Hoping to get the correct answer, I enlisted the aid of my brother, a technical editor of a weekly electronics publication, and he promised to give the matter some thought. Some time later I received a bulky letter which contained photostats of roughly ten pages of a book—doubtless it does contain the answer to the speed of electricity, but I have yet to fathom it out. If any reader can explain it to me on half a page in words of two syllables I shall be delighted to hear from him or her.



Become a radio amateur.

Learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence.

WAA
EE K7

Free!

Brochure, without obligation to:

BRITISH NATIONAL RADIO
& ELECTRONICS SCHOOL,
P.O.Box 156, Jersey, Channel Islands.

NAME ____________________

ADDRESS ____________________ (Block caps please)

SINCLAIR PRODUCTS*
Microvision TV now in stock £200. PDM35 digital multimeter **£25·95.** Mains adaptor **£3·24.** De-luxe padded case **£3·25.** 30kV probe **£18·36.** New DM235 digital meter P.O.A. Cambridge programmable calculator **£13·15.** Prog. library **£4·65.** Mains adaptor **£3·20.**

S-DECS AND T-DECS*
S-DeC **£3·39.** T-DeC **£4·44.** U-DeCA **£4·52.** u-DeCB **£6·73.** 16 dil or 10T05 adaptors with sockets **£2·14.**

TV GAMES KITS
Send s.a.e. for free data. Tank battle chip AY-3-8710 plus economy kit **£17·95.** Stunt motor cycle chip AY-3-8760-1 plus economy kit **£17·95.** 10 game paddle 2 chip AY-3-8600 plus economy kit **£14·70.** AY-3-8500 chip plus economy kit **£8·95.** Modified shoot kit **£4·95.** Rifle kit **£4·95.** Colour generator kit **£7·50.** Joystick controls **£1·70.** 4·43Mhz pal crystals **90p.**

ASSEMBLED TV GAMES
Attractively cased. Tank battle game **£39·95.** Stunt motor cycle game **£39·95.** 4 game models (tennis, football, squash and pelota):— black and white **£11·95.** Colour **£14·50.** De-luxe 6 game colour with pistol attachment **£21·95.** TV games mains adaptor **£3·10.**

MAINS TRANSFORMERS
6-0-6V 100ma **79p,** 1½a **£2·35.** 6·3V 1½a **£1·89.** 9-0-9V 75ma **79p,** 1a **£1·99,** 2a **£2·60.** 12-0-12V 50ma **79p,** 100ma **90p,** 1a **£2·49.** 13V ½a **95p.** 15-0-15V 1a **£2·79.** 30-0-30V 1a **£3·59.**

JC12, JC20 AND JC40 AMPLIFIERS
A range of integrated circuit audio amplifiers supplied with free data and printed circuits. JC12 6 watts **£1·60.** JC20 10 watts **£2·95.** JC40 20 watts **£4·20.** Send sae for free data on our range of matching power and amp kits.

FERRANTI ZN414
ic radio chip **£1·05.** Extra parts and pcb for radio **£3·85.** Case **£1.** Send s.a.e. for free data.

PRINTED CIRCUIT MATERIALS
PC etching kits:— economy **£1·70,** standard **£3·82.** 50 sq ins pcb **40p.** 1 lb FeC1 **£1·05.** Etch resist pens:— Economy **45p,** dalo **73p.** Small drill bit **20p.** Etching dish **68p.**

BI-PAK AUDIO MODULES
Send s.a.e. for data. S450 tuner **£23·51.** AL60 **£4·86.** PA100 **£16·71.** SPM80 **£4·47.** BMT80 **£5·95.** MK60 **£38·74.** Stereo 30 **£20·12.**

BATTERY ELIMINATOR BARGAINS
TV games power unit stabilized 7·7V 100ma **£3·10. 3-way models** with switched output and 4-way multi-jack:— 3/4½/6V 100ma **£2·92.** 6/7½/9V 300ma **£3·30. 100ma radio models** same size as a PP9 battery. With press stud connectors. 9V **£2·85.** 6V **£2·85.** 4½V **£2·85.** 9V + 9V **£4·50.** 6V + 6V **£4·50.** 4½V + 4½V **£4·50. Cassette recorder mains unit** 7½V 100ma with 5 pin din plug **£2·85. Car convertors** 12V dc input. Output 9V 300ma **£1·50.** Output 7½V 300ma **£1·50.**

BATTERY ELIMINATOR KITS
Send s.a.e. for free leaflet on range. **100ma radio types** with press stud connectors. 4½V **£1·80.** 6V **£1·80.** 9V **£1·80.** 4½ + 4½V **£2·50.** 6 + 6V **£2·50.** 9 + 9V **£2·50. Cassette type** 7½V 100ma with din plug **£1·80. Heavy-duty 13 way types** 4½/6/7/8½/11/13/14/17/21/25/28, 34/42V. 1 Amp **£4·65.** 2 Amp **£7·25. Transistor stabilized 8-way types** for low hum 3/4½/6/7½/9/12/15/18V 100ma **£3·20.** 1 Amp **£6·40. Car convertor kit** input 12V dc. Output 6/7½/9V 1A stabilized **£1·95.**

BULK BUY OFFERS
Minimum purchase **£10** any mix. ¼W resistors 5% E12 1 ohm to 10M **0·9p.** 741 8 dil **20p.** NE555 8 dil **32p.** Dalo pens **59p.** Plastic equivs of BC108/BC109 3·8/4·4p. IN4148 **1·9p.** BC107 **7p.** BC109 **7p.** BC212 **8p.** IN4002 **4·2p.** 250V polyester capacitors ·015mf **1·1p.** ·068 mf **7p.** BC212 **8p.** IN4002 **4·2p.** 250V polyester capacitors ·015mf **1·1p.** ·068mf **1·4p.** 0·1mf **1·5p.** 0·33mf **2·5p.** Zener diodes 400mW E24 2V7 to 33V **5·5p.**

COMPONENTS
Resistors 5% carbon E12 10 to 10M. ¼W **1p.** 1W **2p. Polyester** capacitors 250V E6 ·01 to ·068mf **3½p.** 0·1mf **2p.** ·15mf **5p.** ·22mf **4p.** ·33, ·47mf **6p. Polystyrene** capacitors E12 63V 15pf to 6800pf **2½p. Ceramic** capacitors 50V E12 22pf to 1000pf **2½p.** E6 1500pf to 47000pf **2½p. Mylar** capacitors 100V ·001, ·002, ·005mf **4p.** ·01, ·02mf **4½p.** ·04, ·05mf **5½p. Electrolytics 50V** ·47, 1, 2mf **5p.** 25V 5mf **5p.** 10mf **4p. 16V** 22mf **5p.** 33, 47, 100mf **6p.** 220, 330mf **9p.** 470mf **11p.** 1000mf **8½p. zeners** 400mW E24 2V7 to 33V **7½p. Preset pots** sub-miniature 0·1W horiz or vert 100 to 4M7 **8½p. Potentiometers** ¼W 4K7 to 2M2 log or lin. Single **28p.** Dual **76p.**

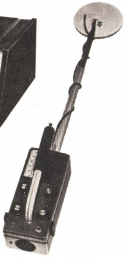
SWANLEY ELECTRONICS

DEPT. EE, 32 Goldsel Rd., Swanley, Kent BR8 8EZ.

Mail order only. Please add **30p** to the total cost of order for postage. Prices include VAT. Overseas customers deduct 7% on items marked * and 11% on others. Official credit orders welcome.

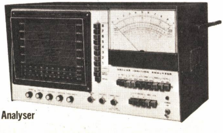
You'll learn a lot from the Heathkit catalogue.

NEW Computer Systems
Send for a special 16 page brochure.



NEW De-luxe Coin-tracking Metal Locator

NEW Bi-directional RF Wattmeter



NEW De-luxe 12"CRT Ignition Analyser

The Heathkit catalogue is packed with scores of top quality electronic kits. Educational, practical and fascinating items which you can build yourself.

Send for the catalogue now.

To Heath (Gloucester) Limited,
Department EE 78 , Bristol Road,
Gloucester, GL2 6EE. (Registered number 606177.)

Name ....

Address ....

....

....

Please tick the literature you want and enclose the appropriate amount in postage stamps.

Heathkit catalogue only ☐ (enclose 20p).

16 page computer brochure only ☐ (enclose 20p).

N.B. If you are already on the Heathkit mailing list you will automatically receive a copy of the latest catalogue without having to use this coupon.

Soldering iron offer FREE

When you receive your catalogue you'll get details of this free offer worth approximately £4.75.

HEATH
Schlumberger
The world's biggest producers of electronic kits.

ACCESS AND BARCLAYCARD WELCOMED

There are Heathkit Electronics Centres at 233 Tottenham Court Road, London (01-636 7349) and at Bristol Road, Gloucester (Gloucester 29451).

MAINS TRANSFORMERS

All these have 230/240v 50Hz Primary

VOLTAGE	CURRENT	REF.	PRICE
1v	2 amp	TM 1	**£1·94**
2·4v	5 amp	TM 2	**£1·62**
4v	7 amp	TM 32	**£2·70**
6v	¾ amp	TM 3	**85**
6·5v	¾ amp	TM 37	**85**
6·5v	200 ma	TM 21	**£1·62**
6·5v–0–6·5v	100mA	TM 21	**£1·62**
6·5v–0–6·5v	750mA	TM 7	**£2·16**
6·3v–0–6·3v	100mA	TM 33	**£1·62**
6·3v	2 amp	TM 4	**£1·89**
8·5v	1 amp	TM 12	**£1·62**
8·5v + 8·5v sep winding	½ amp	TM 12	**£1·62**
9v	1 amp	TM5	**£1·62**
9v	1 amp 'c' core	TM 6	**£1·80**
9v	3½ amp	TM 11	**£2·70**
9v	5 amp	TM 38	**£3·24**
10v	25 amp	TM 15	**£4·86**
10v–0–10v	12½ amp	TM 15	**£4·86**
12v–0–12v	4 amp	TM 27	**£4·32**
12v	½ amp	TM 9	**£1·05**
13v	¾ amp	TM 7	**£2·16**
12v	1 amp	TM 10	**£1·89**
12v–0–12v	50mA	TM 19	**£1·62**
12v–0–12v	1 amp	TM 41	**£3·24**
15v tapped 9v	2 amp	TM 11	**£2·70**
15v	7 amp	TM 27	**£4·32**
15v–0–15v	3½ amp	TM 27	**£4·32**
15v–0–15v	3½ amp	TM 35	**£4·86**
17v	½ amp	TM 12	**£1·62**
18v	¾ amp	TM 13	**£1·90**
20v	½ amp	TM 14	**£1·62**
20v	5 amp	TM 27	**£4·32**
20v	12½ amp	TM 15	**£4·86**
20v–0–20v	6 amp	TM 15	**£4·86**
13v	100mA	TM 21	**£1·62**
24v	1½ amp	TM 16	**£2·12**
24v	2 amp	TM 17	**£2·70**
24v + 2v 7 amp	2 amp	TM 39	**£2·97**
24v	4 amp	TM 40	**£3·78**
25v	1½ amp	TM 18	**£2·43**
26v	2 amp	TM 39	**£2·98**
30v tapped 24, 20, 15 & 12	3½ amp	TM 27	**£4·32**
30v	8 amp	TM 15	**£4·86**
37v	37 amp	TM 34	**£31·86**
40v tapped at 30v, 20v & 10v	6 amp	TM 15	**£4·86**
50v-2 amp with 6·3v shrouded		TM 22	**£4·86**
50v	8 amp	TM 29	**£11·65**
60v	5 amp	TM 24	**£7·02**
75v–3 amp with 6·3v shrouded		TM 23	**£8·10**
75v	4½ amp	TM 24	**£7·02**
80v tapped 60v & 75v	4 amp	TM 24	**£7·02**
100v	1 amp	TM 25	**£7·02**
100v–0–100v	TM 25	TM 25	**£7·02**
130v tapped 120v	½ amp	TM 28	**£3·78**
200v	½ amp	TM 25	**£7·02**
250v–0–250v with 6·3v 2A	50mA	TM 36	**£3·78**
250v	100mA	TM 36	**£3·78**
500v	50mA	TM 36	**£3·78**
260v	60mA	TM 26	**£3·24**
1Kv		TM 44	P.O.A.
2Kv		TM 44	P.O.A.
5Kv	5mA	TM 30	**£7·02**
8·5Kv	10mA	TM 31	**£10·26**

Quantity prices available. Please, unless you are calling, add 25% to your order to cover the cost of carriage.

Quick Cuppa. Mini immersion heater, ideal for taking on holiday, for making a "quick cuppa" tea, or for having by the bedside for baby's feed etc. 250w heater @ 230 volts or approximately 90 watts @ 110 volts. Price **£2·95.**

Neon Screwdrivers. Two useful models:– 7½″ price **70p** and 5½″ price **55p.**

240° 1mA Moving Coil Panel Meter. A large instrument, size approximately 4¼″ square at the front and 4½″ deep. Intended for panel mounting, its scale is calibrated 0–7 and it was intended to be used as rev. counter. **£14** each.

Pressure Switch. Adjustable through a range of pressures from where it can be operated by sucking or blowing to approx. 50 psi—10 amp changeover microswitch, metal body with threaded inlet. Price **£2·90.**

Push-Push Switch. Fixed through panel this is a ratchet action, double pole changeover switch, the contacts we understand are hard gold plated. Spindle is ¼″ diameter so a standard radio knob can be fitted. Price **30p** + 3p. Good quantity available at usual discounts.

C.R.T. Display Unit. We feel this would be easy to convert to an oscilloscope, it has all the necessary ingredients. It is in a case, size 15″ × 10″ × 11″ approx. with a carrying handle and a front protection flap. Plenty of controls and is mains operated through step down transformer. Size of the tube is 3″. Price **£16·75.**

Vu Meter Edgewise mounting, through hole size 1⅛″ × ½″ approx: these are 100 micro amp fsd and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale in not calibrated but has very modern appearance. Price **£1·85.**

Cassette Mechanism. Jap. made to rigid specification. These will fit many music centres and cassette players. Chassis size approx. 4½″ wide by 5¼″ deep, 6v motor and tape position counter at the rear. The six levers for "play", "fast forward", "rewind", "stop", record and eject are all at the front, as is the auto mechanism to stop the motor when tape end is reached. These are new and unused and have record playback and erase heads. Limited quantity. Price **£15·50.**

Shortened 3kW Tangential Heater. This is in fact near enough the same size as the normal 2kW tangential. Motor runs a bit faster to compensate for the increased heating and the fan impellers are metal to save any possibility of extra heat distorting them. The heater element is tapped so that 1, 2 or 3kW's of heating can be used or of course this will blow cold. Price **£8·95,** post £1·50p + 12p.

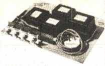
Omron 410 Relay. Built like a contactor, this has a clear plastic cover over the working parts but the terminals are all brought out of the front so that connection may be made without removing the cover, also the relay may be fitted into position and the wires brought to it afterwards, generously rated at 10 amps the contracts are really more like 15 amps, they are changeover and there are 4 sets of them. A really robust relay which looks as though it will give a lifetime of service. Size 3½″ × 3″ × 3½″ high. Price **£4·50.**

8 Track Cartridge Players. In car units with amplifiers but this amplifier may need attention, mechanism guaranteed O.K. **£9·00** + 19p.

Low rpm Crouzet Motors. Twomore types have just come in; these are 2 rpm and 15 rpm, both 115v motors but as these consume only two to three watts it is a simple matter to divide the mains voltage using a mains working condenser, resistor auto transformer or of course use them in pairs. Price **£2·50.**

12 volt Miniature Relay. Gold plated contacts with plastic dust covers 4 sets of changeover contacts, **90p,** bases **45p.**

MULLARD UNILEX



A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of Plessey speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£15** including VAT and postage.

SPIT MOTOR WITH CARTER G/BOX

Probably one of the best spit motors made. Originally intended to be used in very high priced cookers, however this can be put to plenty of other uses, for instance your garden barbeque or to drive a tumbler for stone polishing; in fact there are no ends to its uses. Normal mains operation. **£4·82.**

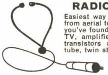
PP3/PP9 REPLACEMENT MAINS UNIT

Japanese made in plastic container with leads size 2″ × 1½″ × 1½″, this is ideal to power a calculator or radio, it has a full wave rectified and smoothed output of 9 volts suitable for a loading of up to 100mA. **£2·53.**

SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·94—**crystal earphone **55p** including VAT and postage.

RADIO STETHOSCOPE



Easiest way to fault find, traces signal from aerial to speaker when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube, twin stetho-set. **£3·95.**

BREAKDOWN PARCEL

Four unused, made for computer units containing most useful components, and these components unlike those from most computer panels, have wire ends of usable length. The transistors for instance have leads over 1″ long—the diodes have approx. ½″ leads.

List of the major components is as follows:—17 assorted transistors—38 assorted diodes—60 assorted resistors and condensers—4 gold plated plugs in units which can serve as multipin plugs or as hook up boards for experimental or quickly changed circuits (note we can supply the socket boards which were made to receive these units). The price of this four unit parcel is **£1** including VAT and post (considerably less than value of the transistors or diodes alone). DON'T MISS THIS SPLENDID OFFER.

INFRA RED BINOCULARS

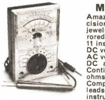
Made for military purposes during and immediately after the last war to enable snipers, vehicle drivers, etc. to see in the dark. The binoculars have to be fed from a high voltage source (5KV approx.) and providing the objects are in the rays of an infra red beam then the binoculars will enable these objects to be seen. Each binocular eye tube contains a complete optical lens system as well as the infra red cell, technical data on which is available. The binocualars are unused, believed to be in good order. Sold without guarantee.

Price **£25·00** per set.

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£9·95.**

MINI-MULTI TESTER



Amazing, deluxe pocket size precision moving coil instrument—jewelled bearings—1000 opv—mirrored scale.

11 instant ranges measure:—
DC volts 10, 50, 250, 1000
AC volts 10, 50, 250, 1000
DC amps 0–1 mA and 0-100 mA
Continuity and resistance 0-150K ohms.

Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only **£6·50p**

FREE Amps ranges kit enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly, but if you already own a mini tester and would like one send £1·50p.

Terms: Unless Stated Prices include Post & VAT. But orders under £6·00 please add 50p to offset packing. Bulk enquiries—Please Phone for Generous Discounts 688 1833.

J. BULL (ELECTRICAL) LTD

(Dept. E.E.), 103 TAMWORTH RD.,
CROYDON CR9 1SG

IT'S FREE!

Our monthly Advance Advertising Barbargains List gives details of bargains arriving or just arrived—often bargains sell out before our advertisement can appear—It's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lists.

Mains Transformer. Small 2 secondaries, 115 volts at 10 mA and 6·3 volt @ ½A, a useful transformer for many instruments. **£2·70.**

25 Watt Audio Systems in Cabinets. Comprising 8″ woofer and 3″ tweeter with crossover and terminal connection panel, mounted in simulated teak finish cabinet with fabric front. These are extremely good quality units comparable with those selling at twice the price. Cabinet size approx. 20″ high 10¾″ wide and 8½″ deep, heavy cabinet made of thick blockboard. Price **£25·00** the pair, well worth your coming in to collect them but if you cannot collect them, then still worth adding £5·00 the pair for carriage.

Another Special Item, for callers this month is a pen recorder. Mains operated this is biggish instrument which probably cost originally several hundreds of pounds. We are having a reverse auction on this £40.

Opto Electronics. Two special bargains in this field, the OPCP 70, price **75p** and the ORP 12, price **85p.**

Tilt Switch 15 amp. Meant to switch off heater should it be knocked over; this pendulum operated switch is on only when it is in the upright position. It could be incorporated in burglar alarm, car alarms etc. Contacts look quite able to cope with 15 amp loads at mains voltage. Price **50p** + **4p.**

Neon Indicator Lamp. Two features about this particular one are—it has screw down terminal connectors for wiring and is fixed by a single threaded screw. The lens is clear so you could colour to suit your neesd. Price **35p.**

Indicator Lamp Holders. For low voltage lamps (Liliput) type, we have these in five different colours—red, yellow, blue, green and white. Price **35p.**

Twin Padded Flex. 5 amp ideal for some electric irons and appliances which require very flexible lead, 10 metre lengths. Price **£1·50.**

Heating Pads. These measure 11″ long × 8¼″ wide and are flat. Look rather like pieces of thick blotting paper. Wire ended 250 watt or joined in series they would be approximately 60 watt each. Dozens of uses. Price **80p** or two for **£1·50.**

Rod Thermostat. For high temperatures up to 550°F. This is adjustabel either at the head or remotely by a length of flexible drive. Price **£2·95.**

Interval Timer. As used in schools and similar establishments to trigger off the bell which sounds the end of lessons, lunch breaks etc. This is another one off item we feel for callers only. It is in polish hardwood case, glass fronted, comprises a 24 hour switch, a large brass disc and other smaller discs on which the time is set out in relatively small intervals and a pair of contacts to switch a bell or something similar at precise times during the week. Price **£55·00.**

Two More Mullard Modules. Pre amp module ref. 1181/1183, stereo or mono. It is on a printed circuit board with wire connections. Supplied complete with connection diagram. Price **99p.**

Mullard IF Module Type 1181. In a metal case 2⅜″ long × 1⅛″ wide × ⅝″ thick. Can be mounted on a printed circuit board connection to wire lead outs. Price **£1·25.**

Silicon Diodes. Two special bargains this month. 400 volt 1 amp, 10 for **£1·25.** 50 volt 1 amp, 20 for **£1·25.** Large quantities available at very much discounted prices.

Flex Cable Bargains. Core size ·5mm white pvc outer, pvc covered cores. Coloured coded with the usual blue, brown and green/yellow. Price 100 metre coil for **£10·25.**

Electrical Installation Work. We have good stocks of all the mains items required for ring mains and light installations for example we have 2·5mm twin and earth pvc covered at **£15.** We hope to make a complete list of the installation items we have in time for our next newsletter but if there is anything you are wanting by all means give us a ring.

Plastic Case Sections. Small very tough plastic cases at very reasonable prices, always repeatable. The case is 2–11/16″ long. Section A is ¾″ deep and section B 1″ deep ,use 2AA's, 2BB's or an A and a B to get different depths, i.e. 1½″, 1¼″ or 2″–note these are external dimensions, the wall thickness of the case of 15″ thick. Price, section A **25p,** B **30p.**

Computor Capacitors. Made by famous American companies for working under very exacting conditions. These are large condensers in Alicans for upright mounting. Ideal if you want to make a large storage bank 15.500 uf 10 volts working 15 volts surge, 10 for **£8.**

Alarm Bells. Holiday time can often be a heyday for house breakers; why not fit a really loud alarm as good a method as any is to use trigger mats under carpets, at windows and doorways. Join them all in series through a latching circuit to sound off a really loud bell or hooter, prices of these various parts are as follows:

Loud Ringing Bell, industrial type with 6″ gong, 24v, DC operated, price **£7·50.**

Switch Trigger Mat, size 24″ × 18″ for going under carpet etc. Price **£2·50. 24v Relay** with latching contacts, Price **95p.**

Secret Switch with key, Price 85p.

24v 1 amp DC Power Supply Price **£5·50.**

Circuit Diagram. No charge, just request.

Mouth operated Switch. Probably not made with this use in mind, more likely made for washing machines to control water level etc. this is a **sensitive low pressure** device which operates three 1 pole changeover switches at different levels of pressure but all within a normal persons blowing capacity—blow gently into it and No. 1 switch operates, blow a little stronger and No. 2 operates, blow harder still and No. 3 operates. The switch is airtight so weight of water or other fluid substance could operate it. Undoubtedly a switch with very many applications. Disc type construction, this is approximately 3½″ dia. × 1⅜″ thick—the air entry is a pipe approximately 3/16″ diameter—electrical contacts we estimate a 10 amp c/o a 230 volt connection by push on tags. Order ref. PS.4. Price **£1·95.** Large quantity available.

Powerful Induction Motor. 1½″ stack, double ended, would drive a small lathe, drill or grinder or would power a blowing or extracting fan. Fit suitable pulleys and it would drive a pebble polisher or similar, being double ended it will drive in either direction. Can also be fixed from either end, fixing bolts are fitted and these are 1⅞″ apart. Spindles ½″ diameter, extend 1¾″ beyond each end plate. A motor like this would cost at least £3 from makes but we have a large quantity to offer at **£2·50,** Order Ref. MM.10.

Can any reader help–We urgently used some reasonably priced decoders to go with the F.M. tuner we have. If you can help us to find a supply we will be very much obliged and will try to do you a good turn some day—thank you.

SMALL ADS

The prepaid rate for classified advertisements is 16 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £4·00 per single column centimetre. All cheques, postal orders, etc., to be made payable to Everyday Electronics and crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Everyday Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5918).

CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

1. Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any Act of Parliament nor is it an infringement of the British Code of Advertising Practice.

2. The publishers reserve the right to refuse or withdraw any advertisement.

3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

Receivers and Components

7lb ASSORTED COMPONENTS £2·95. Small Audio Amplifiers. 3 transistors equivalent to AC128. OC72, with circuit. 3 for £1. 300 small components, Transistors, Diodes £1·30. No Postage, list 15p refundable. Insurance add 15p. J.W.B. Radio, 2 Barnfield Crescent, Sale, Cheshire M33 1NL.

NO LICENCE EXAMS NEEDED

To operate this miniature, solid-state **Transmitter-Receiver Kit.** Only £9·75 plus 25p P&P.
'Brain-Freeze' 'em with a MINI STROBE Kit, pocket-sized 'lightning flashes', vari-speed, for discos and parties. A mere £4·10 plus 20p P&P.
Experiment with a psychedelic DREAM LAB, or pick up faint speech/sounds with the BIG EAR sound-catcher; ready-made multi-function modules. £5·00 each plus 20p P&P.
LOTS MORE! Send 20p for lists. Prices include VAT. (Mail order U.K. only).

BOFFIN PROJECTS
4 CUNLIFFE ROAD, STONELEIGH
EWELL, SURREY. (E.E.)

DISCOVER ELECTRONICS. Build forty easy projects including: Metal Detector; Wireless Transmitter; Breathalyser; Radios; Stethoscope; Lie Detector; Touch time-switches; Burglar Alarms, etc. Circuits, plans all for £1·29 including FREE circuit board. Mail only. RIDLEY PHOTO/ELECTRONICS, Box 62, 111 Rockspark Road, Uckfield, Sussex.

Miscellaneous

ENAMELLED COPPER WIRE

swg	1 lb	8 zo	4 oz	2 oz
14–19	2·40	1·20	·69	·50
20–29	2·45	1·60	·82	·59
30–34	2·60	1·70	·89	·64
35–40	2·85	1·90	1·04	·75

Inclusive of p&p and VAT. SAE brings Catalogue of copper and resistance wires in all coverings.

THE SCIENTIFIC WIRE COMPANY
PO Box 30, London E4 9BW
Reg. Office: 22 Coningsby Gardens

DISCOVER THE PLEASURE of Electronic Games, including TV Football, Tennis, Squash, Practice; TV Tank Game; Battleships; Noughts & Crosses; Roulette. Cheap and easy to build (TV Football less than £10). Eight circuits, plans for only £1·85. Orders to: RIDLEY PHOTO/ELECTRONICS, Box 62, Uckfield, Sussex (reg. office, Wallsend House, Pevensey Bay, Sussex).

ARMATURES, Armatures B and D, Wolf, Bridges Makita etc. Exchange armatures and fields for most power tools obsolete models covered. S.A.E. for quotation or ring 061-799 0624. INTER-Q-CONTROL, 26 Broadway, Worsley, Manchester.

100 RESISTORS 75p
¼W 5% c/FILM 2·2Ω–2·2M Ω (E12)
10 each of any value
Send stamped envelope for free sample

C60 CASSETTES 30p
690 CASSETTES 45p

All Cassettes in Plastic Case with Index and Screwed Assembly.

All prices include VAT.

Add Postage 10p in £1

Quantity Discounts
10 Units 5%
50 Units 7%
100 Units 10%

SALOP ELECTRONICS,
23 WYLE COP,
SHREWSB
Tel.53206 URY.

STYLI—illustrated equivalents (List 28) also cartridges, leads, etc. Superb quality and service at lowest prices. Fully guaranteed, free for SAE from: FELSTEAD ELECTRONICS (EE), Longley Lane, Gatley, Cheadle, Cheshire SK8 4EE.

EVERYDAY ELECTRONICS PCB's

In top quality glass fibre tinned and drilled. For full list and current boards please send SAE also produced from customers own masters please send for quote.

PROTO DESIGN, 4 Highcliffe Way, Wickford, Essex SS11 8LA.

METAL DETECTOR KIT type "MD1" (Home Office approved). Supersensitive. Operates with Transistor radio, only £3·75. VOX KIT "AO3-VR" High performance. Relay output module £9·75. Other easy-buildkits available. 16p stamps for illustrated catalogue. WELLTEX Co., 9 Sirdar Strand, GRAVESEND, KENT.

Books and Publications

WHAT'S THE SECRET OF MAKING MONEY? The Knowledge, and ability, that very few people possess, to undertake work in a specialised field that is crammed with opportunities. We are supplying a MANUAL that will enable you, in your own home, WITH NO PREVIOUS EXPERIENCE, to repair VACUUM CLEANERS, DRILLS, and PORTABLE TOOLS, by showing in easy, step by step stages, how to diagnose faults, rewind ARMATURES and FIELDS and make up test equipment. 13 chapters covering test procedures, apparatus required, test charts, where to obtain materials and where to find work. Packed with diagrams and information. Get your copy now. Only £4 plus 30p P&P. CWO. COPPER SUPPLIES, 102 Parrswood Road, Withington, Manchester 20, Dept. EE1.

SIMPLIFIED TV REPAIRS. Full repair instructions individual British sets £4·50, request free circuit diagram. Stamp brings details unique TV publications. Ausee, 76 Church Street, Larkhall, Lanarkshire.

REWINDING TRANSFORMERS a new publication covering how to repair, design and rebuild them. Every fact including where and how to get this class of work. £4·30p post paid by return, from MAGNUM POWER TOOLS, Brinksway Trading Estate, Stockport, Cheshire SK3 0BZ.

Service Sheets

BELL'S TELEVISION SERVICE for service sheets of Radio, TV etc. 75p plus SAE. Colour TV Service Manuals on request. SAE with enquiries to BTS, 190 King's Road, Harrogate, N. Yorkshire. Tel: 0423 55885.

SERVICE SHEETS for Radio, Television, Tape Recorders, Stereo, etc. With free fault-finding guide, from 50p and s.a.e. Catalogue 25p and s.a.e. Hamilton Radio, 47 Bohemia Road, St. Leonards, Sussex.

For Sale

FOR SALE BACK COPIES from 1972 to 1977. 6 copies for £1·40 p.p. Open Postal Order. 3 Marple Road, Charlesworth, Broadbottom, Via Hyde, Cheshire SK14 6EY.

ELECTRONIC KITS—SAE for new catalogue, and clearance list of obsolete kits. AMTRON UK, 7 Hughenden Road, Hastings, Sussex.

NEW BACK ISSUES of "EVERYDAY ELECTRONICS". Available 60p each Post Free, open PO/Cheque returned if not in stock. BELL'S TELEVISION SERVICES 190 Kings Road, Harrogate, Yorkshire. Tel: (0423) 55885.

TRANSISTORS, Thyristors, Diodes, Led, Zeners, Voltage Regulators, Tracs, Bridge Rectifiers, Plugs, Sockets ALL NEW. Cheap E.G. 2N3773 ·2 15p, BFY90 95p, BD 131 45p. SAE list. JAI Electronics, 39 Balvernie Gro, London SW18 5RR.

NOTICE TO READERS

When replying to Classified Advertisements please ensure:

(A) That you have clearly stated your requirements.
(B) That you have enclosed the right remittance.
(C) That your name and address is written in block capitals, and
(D) That your letter is correctly addressed to the advertiser.

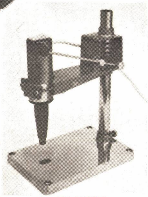
This will assist advertisers in processing and despatching orders with the minimum of delay.

A NEW SUPER DRILL
from
PRECISION PETITE

An extra powerful precision drill for Electronic Design and Development Engineers who need a small, low voltage, precision drill with high capacity, and there's a new all metal stand for greater accuracy.

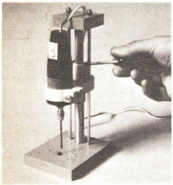
P2 Mk2 with detachable head (without case) £18·00 pp 86p
In storage case with room for Transformer £19·50 pp 86p
In case with variable transformer £29·00 pp 86p

P2 Mk2 DRILL



S2 Drill stand (holds both drills) £18·50 pp 106p

and the popular P1 DRILL



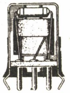
P1 Drill £9·67 p & p 38p
S1 Stand £5·13 p & p 38p
Accessories include drills, stones, burrs, saw blades etc. Send 9" × 4" S.A.E. for full details and order form.

TRY OUR SPADE DRILLS — ideal for P.C.B.'s — giving cleaner holes, no clogging, cooler. Range of sizes from 0·1 to 2·5mm.
Send for details to:

Sole UK Distributors
PRECISION PETITE LTD
119a HIGH STREET
TEDDINGTON MIDDLESEX TW11 8HG
TEL: 01-977 0878

DENCO (CLACTON) LIMITED
Dept. E.E.

357-8-9 OLD ROAD
CLACTON-ON-SEA
ESSEX CO15 3RH



Our components are chosen by technical authors and constructors throughout the world for their performance and reliability, every coil being inspected twice plus a final test and near spot-on alignment.
General Catalogue showing full product range 36p. Overseas Customers 70p, Air-Mail Post Paid.

U.K. & OVERSEAS MANUFACTURERS/STOCKISTS ENQUIRIES WELCOME

Australian Readers Please Note—Our Complete Range of Coils are available from Watkin Wynne Pty. Ltd., 32, Falcon Street, CROWS NEST, 2065, AUSTRALIA. P.O. Box 392.

PLEASE MENTION EVERYDAY ELECTRONICS WHEN REPLYING TO ADVERTISEMENTS

WHAT'S NEW?

The most MODERN, RAPID ECONOMIC way to master space age electronics.
Starting even from ZERO by performing over

100 EXPERIMENTS

creating more than 20 practical applications

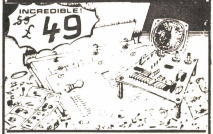
You learn all about the most up to date electronic circuits; how to calculate, repair, and design them, while pursuing your favourite hobby. Start from scratch, or improve your present knowledge, train and earn money in your spare time, turn your pastime into valuable job opportunities.
Compare our prices: you receive the entire course, "mini laboratory" and components for LESS than the price of the components alone.

COMPLETE KIT: nothing else to buy*

You get:
— Instruction manual: over 200 pages of detailed step-by-step instructions. Start from scratch, explains basic laws and physics of Electricity, semiconductor principles and operation electronic circuits: form diodes (including diac, zener) transistors, triacs to integrated circuits (C.MOS, operational amplifiers) etc. . .
Over 200 Electronic components: aerospace technology. Printed circuit experiment board, phototransistor, triac, thyristor I.C.S. transistors (including FET, MOSFET) LEDS plus resistors, capacitors, milliameter, potentiometers, variable capacitor, etc . . . etc . . . etc . . .
measuring instruments (you assemble yourself from among components furnished in kit).
ELECTRONIC VOLTMETERS, LOW FREQUENCY MEASURING AMPLIFIER, LOGIC INDICATORS, REGULATED POWER SUPPLY. MULTIAMTER.

You perform:
Over 100 different experiments: from the most basic voltage measurements to radio transmitter circuits and including HI FI, Flip Flops, Ic applications, Triac use, etc . . . etc . . . etc . . .

You construct:
More than 20 complete functional systems: light modulator, high fidelity amplifier, radio control set, radio receiver and transmitter, electronic gadgets and games and many, many more.
*Hand tools not furnished·



SAVE £10 - mail coupon today - SAVE £10

saga
SAGA ENGLAND, P.O. Box 401,
King's Mead, King's Lane,
Chipperfield, Nr King's Langley,
Herts. WD4 9PB.

Please send me ——— (QTY) IK2 KIT(S)
I enclose cheque (money order) for
£ ____________________
Name ____________________
Address ____________________
____
____
____
C

ELECTROVALUE

All the many types of components we supply are BRAND NEW and guaranteed and only from manufacturers direct or approved suppliers. (No surplus, no seconds)

CMOS—buffered and protected (BE)

4000	**23p**	4013	**51p**	4023	**23p**	4043	**1·00**	4081	**23p**
4001	**23p**	4014	**1·04**	4024	**1·04**	4044	**94p**	4082	**26p**
4002	**23p**	4015	**1·14**	4025	**23p**	4046	**1·40**	4510	**1·42**
4006	**1·14**	4016	**51p**	4026	**1·75**	4049	**54p**	4511	**1·50**
4007	**23p**	4017	**1·14**	4027	**60p**	4050	**53p**	4514	**3·30**
4008	**99p**	4018	**1·32**	4028	**95p**	4060	**1·40**	4516	**1·44**
4009	**62p**	4019	**62p**	4029	**1·23**	4069	**30p**	4518	**1·26**
4010	**63p**	4020	**1·32**	4030	**51p**	4070	**50p**	4520	**1·26**
4011	**23p**	4021	**1·14**	4041	**84p**	4071	**26p**	4543	**1·30**
4012	**23p**	4022	**1·13**	4042	**96p**	4072	**26p**	4583	**1·45**

OUR COMPUTER TAKES GOOD CARE OF VOUR ORDERS

SIEMENS CAPACITORS ●
World-famous for quality and dependability–exceptionally large stocks held.
PCB TYPES—7·5mm PCM 0·001 to 0·01 **5p** each: 0·015 to 0·047 **6p** each: 0·068, 0·1 **7p** each.
CERAMIC—2·5mm PCM 0·01, 0·022 **4p**: 0·033, 0·047 **5p** each: 0·068 **6p** each: 0·1 **7p.**
ELECTROLYTICS—1/100, 10/25, 10/63, 100/25, etc. etc.
For full range see our current lists.

RESISTORS
$\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$ watts **2p** ● each: metal film, metal oxide and 1 watt carbon **5p** ● each: *Good quantity discounts*. Magnetic field dependent from **£1·50**. Hall effect from **£1·23**.

SIEMENS TRANSISTORS
Silicon npn and pnp from **8p** each: LEDs, red **19p**: yellow or green **23p** (3 or 5mm): Photo transistors from **76p.**

KEEN PRICES ● GOOD SERVICE ● WIDE RANGES

DISCOUNTS
5% if list value of order over £10
10% if list value of order over £25
—where cash (P.O. or cheque) is sent with order.

V.A.T.—Add 8% to value of order or 12½% with items marked.
(No V.A.T. on overseas orders).
Goods sent post free on C.W.O. orders in U.K. over £5 list value. If under, add 27p per order.

MONTHLY BARGAIN LISTS S.A.E. brings monthly list of bargains. Also current quick reference price list of all ranges.

Cash with order (P.O. or cheque payable to **Electrovalue Ltd)** or your Access or Barclaycard number.

TRADE AND INDUSTRIAL ENQUIRIES INVITED
For all round satisfaction—be safe—buy it from **ELECTROVALUE**

ELECTROVALUE LTD

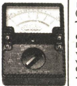
Dept E.E.8, 24 St. Judes Rd, Englefield Green, Egham, Surrey TW20 0HB.
Phone Egham 3603. Telex 264475.
Northern Branch (Personal shoppers only), 680 Burnage Lane, Burnage, Manchester M19 1NA. Phone (061) 432 4945.

CRESCENT RADIO LTD.

MAIL ORDER DEPT. 1 St Michaels Terrace, Wood Green
London N22 4SJ Phone 888-4474

MULTIMETER BARGAINS
A special bulk purchase of Eagle Multimeters enables us to offer two from their range at up to 15% off Eagle's own recommended retail price.

EP20KN



20,000 opv multimeter with anti-parallax mirror, 'off' damping. **DC volts:** 0 to 0·25, 5, 25, 125, 500, 1,000 (20,000 opv). **AC volts:** 0 to 10, 50, 250, 1,000 (10,000 opv). **DC current:** 0 to 50 uA, 2·5 mA, 250 mA. **Resistance:** 0 to 60K, 600K, 6 Meg. **Decibels:** −20 to +22 dB. **Dimensions:** 118 × 86 × 34 mm.
PRICE **£16·16**+ 8% VAT.

POWER SUPPLY UNIT TYPE 'PP1'
Switched 3, 4½, 6, 7½, 9 and 12 volts at 500mA. With on/off switch and pilot light.
Size: 130mm × 55mm × 75mm approx.
OUR PRICE:
Only £6·00 + 8% VAT

C1095 20,000 opv multimeter with hinged 4-position scale for easy-reading bench use. Anti-parallax mirror, 3-colour scale, overload protection.
Ranges: DC volts: 5, 25, 50, 250, 500, 2,500 (20,000 opv). **AC volts:** 10, 50, 100, 500, 1,000 (10,000 opv). **DC current:** 50 uA, 2·5 mA, 250 mA. **Resistance:** 50 K, 5 meg. **Decibels:** −20 to +22 dB. **Dimensions:** 140 × 85 × 35 mm.
PRICE: **£14·31** + 8% VAT

ABS PLASTIC BOXES
Handy boxes for construction projects. Moulded extrusion rails for P.C. or chassis panels.
Fitted with 1mm Front Panels.
1005 = 105 × 73 × 45mm = **85p**
1006 = 150 × 74 × 47mm = **£1·05**
1022 = 107 × 85 × 45mm = **80p**
(sloping front) Plus 8% VAT.

BARGAIN LOUDSPEAKER
Goodmans 5". 8 ohm long throw H/D loudspeaker. Mounting plate is integral with L/S Chassis and has fixing holes with centres spaced at 5¼" (diagonally).
ONLY **£5·00** + 12½% VAT.

A CRESCENT 'SUPERBUY'!
HEAVY DUTY X OVER 8 OHM
A 2 way 8 ohm H/D Xover suitable for L/S systems up to 100 watt.
Fitted with screw terminals for input and a 3 position 'HF LEVEL' switch which selects either Flat, −3dB or −6dB.
A real bargain at only **£3·50** + 8% VAT.

BARGAIN PROJECT BOX
A Plastic Box with moulded extrusion rails for P.C. or chassis panels with metal front plate fitted with four screws (all supplied).
Size: (internal): 81 × 51 × 28mm.
PRICE: **60p** + 8% VAT.

FERRIC CHLORIDE
Anhydrous Ferric Chloride in double sealed one pound 'Polypaks'.
PRICE: **£1·15** per lb + 8% VAT.

'BARGAIN TRANSFORMER'
240v PRIMARY 12–0–12v, 500m/A SEC. Approx. size: 60 × 40 × 50mm.
Fixing centres: 75mm.
PRICE: £1·80 + 8% VAT.

ACCESS AND BARCLAYCARD ACCEPTED—PHONE ORDERS WELCOMED, ALL PRICES INCLUDE POSTAGE—PLEASE ADD VAT AS SHOWN—S.A.E. WITH ALL ENQUIRIES PLEASE.
Personal Callers Welcome at: 21 Green Lanes, Palmers Green London, N.13. Phone: 888-3206 and 13 SOUTH MALL, EDMONTON, N.9. Phone: 803-1685.

E.E. PROJECTS

CHASER LIGHT DISPLAY. Feb. 78. £19·56 inc. p.c.b. Case £3·47.
A.C. METER CONVERTER. Feb. 78. £4·25 inc. case.
AUDIOTEST. March 78. £19·91 less case. Front Panel 66p.
CATCH A LIGHT. March 78. £4·32. Case £1·32. Switch cases 55p each.
C/R SUBSTITUTION BOX £6·20. Case £0·97 (¼W Resistors).
WEIRD SOUND EFFECTS GENERATOR. March 78. £3·63 inc. case.
ELECTRONIC TOUCH SWITCH Jan 78. £1·44.
AUTOMATIC PHASE BOX. Dec. 77. £8·80 inc. p.c.b. and case.
CAR SYSTEM ALARM. Feb. 78. £3·68 inc. case.
AUDIO VISUAL METRONOME. Jan. £3·99 inc. case.
POCKET TIMER April. 78. £4·09 inc. case.
TRANSISTOR TESTER. Oct. 77. £6·40, case extra £2·98.
PHOTOFLASH SLAVE. Dec. £3·68 inc. case. Less lead.
SHORT WAVE RECEIVER. Aug. £9·38. Case £1·55.
DICE. March. £4·24 inc. case.
SOIL MOISTURE. June. £2·95 inc. case and probe.
PHONE/DOORBELL REPEATER. July. £4·70 inc. case.
RAPID DIODE CHECK. Jan. £2·12 inc. case.
FUZZTONE UNIT. July. £5·75 exc. case.
ADD ON CAPACITANCE UNIT Sept. £4·50 inc. case.
FLASHMETER May 78 £8·38 Case £1·55 Less Calculator and Diffuser.
CONSTRUCTIONAL ARTICLES 29p each.

1978 COMPONENTS CATALOGUE ● MAGENTA ●

Magenta gives you a wide range of the things you need—components—tools—hardware—and lots more. First-class delivery. NO minimum order. Inclusive prices. All products stock lines. Illustrated catalogue with data. Send 2 × 9p stamps.
This Catalogue is a MUST for constructors. Write Today!

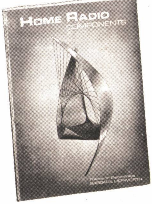
VHF RADIO. Nov. £10·20 inc. case.
TREASURE LOCATOR. Oct. £7·98. Case £2·49.
SIGNAL INJECTOR AF/RF probe and leads £4·98.
MULTIMETER. TYPE 1. 1,000 o.p.v. with probes. 2" × 3½" × 1" £5·95.
MULTIMETER. TYPE 2. 20,000 o.p.v. with case and probes 5" × 3½" × 1¾" £10·95.
ANTEX X25 SOLDERING IRON 25W. Ideal for electronics £3·68.
SOLDERING IRON STAND. ANTEX ST3 £1·55.
DESOLDER BRAID. 62p.
HEAT SINK TWEEZERS 12½p.
DRILL. 12 VOLT. 10,000 r.p.m. Hand or stand use £10·05.
DRILL STAND. Adjusteble height. £5·51.
TRANSFORMER for 12V drill £8·37.
BUZZER. 6V. 74p.
INTERCOM. 2 station desk model. Cable and battery £5·95.
HEADPHONES. STEREO. 8 ohm. 13-15 KHz. Padded £3·85.
HEADPHONES. MONO. 2K ohms. Sensitive. £2·50.
PHONE PICK-UP COIL. 3·5mm plug. 65p.
EYEGLASS. Jewellers magnification × 3. 93p.
TRIPLE MAGNIFIER. Each lens × 5 magnification. £1·15.
DENTISTS MIRROR. Adjustable £1·70.
SCREWDRIVER SET. 6 miniature jewellers type, in case, £2·40.
SPEAKERS. Miniature 8 ohm 59p. 64 ohm 85p. 80 ohm £1·15.
EARPIECES. Crystal 38p, magnetic 15p.
F.M. INDOOR AERIAL 49p.
S-DEC £2·20.
T-DEC £3·98.
U-DEC B £7·58.
TELESCOPIC AERIAL. 6 section. 70cm. 95p.

MAGENTA ELECTRONICS LTD., EE6, 61 Newton Leys, Burton-on-Trent, Staffs. DE15 0DW. 0283-65435.

TEACH-IN '78 COMPLETE KIT £13·95

Includes FREE Component Identification Chart and Catalogue.

THIS is the Catalogue you need to solve your component buying problems!



- The finest components catalogue yet published.
- Over 200 A-4-size pages.
- About 5,000 items clearly listed and indexed.
- Nearly 2,000 illustrations.
- Bargain List sent free.
- At £1·40, incl. p. & p., the catalogue is a bargain.

Send the coupon below now.
HOME RADIO (Components) LTD.,
Dept. EE., 234-240 London Road,
Mitcham, Surrey CR4 3HD

POST THIS COUPON
with cheque or P.O. for £1·40

Please write your Name and Address in block capitals

NAME..

ADDRESS ....

....

....

HOME RADIO (Components) LTD., Dept. EE
234-240 London Road, Mitcham, Surrey CR4 3HD

(Regn. No London 912966)

Marshall's

Come and get a great deal

Call in and see us 9-5.30 Mon-Fri 9-5.00 Sat
Express Mail Order Tel. orders on credit cards £10 min.
Trade and export enquiries welcome

A. Marshall (London) Ltd, Dept: EE London: 40-42 Cricklewood Broadway, NW2 3ET Tel: 01-452 0161/2 Telex: 21492 & 325 Edgware Rd, W2 Tel 01-723 4242 **Glasgow:** 85 West Regent St, G2 2QD Tel: 041-332 4133 **Bristol:** 1 Straits Parade, Fishponds Rd, BS16 2LX Tel: 0272 654201

PLEASE NOTE ALL OUR PRICES NOW INCLUDE VAT

TRANSISTORS

				2N3390	0·50	2N3905	0·18	2N5086	0·30	2N6107	0·45	AD161	1·00	BC168B	0·13	BC184LC	0·15	BC303	0·54	BD139	0·43	BD530	0·55
				2N3391	0·40	2N3906	0·18	2N5087	0·30	2N6108	0·55	AD162	1·00	BC168C	0·13	BC212	0·15	BC307	0·16	BD140	0·43	BD535	0·70
2N696	0·39	2N2195A	0·40	2N3391A	0·45	2N4031	0·55	2N5088	0·30	2N6109	0·55	AF106	0·60	BC169B	0·13	BC212A	0·15	BC307A	0·16	BD181	1·90	BD536	0·70
2N697	0·31	2N2217	0·55	2N3392	0·17	2N4032	0·65	2N5089	0·30	2N6111	0·49	AF109	0·52	BC169C	0·13	BC212B	0·15	BC307B	0·16	BD182	2·20	BD537	0·74
2N698	0·49	2N2218	0·35	2N3393	0·17	2N4036	0·72	2N5190	0·65	2N6121	0·41	BC107	0·16	BC177	0·22	BC212L	0·18	BC308	0·16	BD183	2·35	BD538	0·77
2N699	0·58	2N2218A	0·38	2N3394	0·17	2N4037	0·60	2N5191	0·75	2N6122	0·44	BC107A	0·16	BC177A	0·22	BC212LA	0·18	BC308B	0·16	BD187	0·95	BD539	0·60
2N706	0·30	2N2219	0·38	2N3395	0·19	2N4058	0·22	2N5192	0·80	2N6123	0·48	BC107B	0·16	BC177B	0·25	BC212LB	0·18	BC309A	0·16	BD235	0·46	BD540	0·60
2N706A	0·30	2N2219A	0·39	2N3396	0·19	2N4059	0·17	2N5193	0·75	2N6124	0·45	BC108	0·16	BC178	0·22	BC213	0·15	BC309B	0·16	BD236	0·44	BDX14	1·32
2N708	0·30	2N2220	0·39	2N3397	0·19	2N4060	0·22	2N5194	0·80	2N6125	0·47	BC108A	0·16	BC178A	0·25	BC213A	0·15	BC309C	0·16	BD237	0·44	BDX18	1·90
2N718	0·30	2N2221	0·25	2N3438	0·85	2N4061	0·19	2N5195	0·97	40361	0·55	BC108B	0·16	BC178B	0·35	BC213B	0·15	BC327	0·22	BD238	0·44	BDY20	1·10
2N718A	0·54	2N2221A	0·25	2N3440	0·75	2N4062	0·20	2N5245	0·37	40362	0·55	BC108C	0·17	BC179	0·25	BC213C	0·15	BC328	0·20	BD239A	0·44	BDY55	1·90
2N720A	0·85	2N2222	0·25	2N3441	0·92	2N4064	1·35	2N5246	0·38	40363	1·45	BC109	0·16	BC179A	0·25	BC213L	0·17	BC337	0·20	BD239C	0·59	BDY56	2·10
2N722	0·45	2N2222A	0·25	2N3442	1·45	2N4074	2·65	2N5247	0·44	40408	0·82	BC109B	0·17	BC179B	0·25	BC213LA	0·17	BC338	0·23	BD240A	0·49	BF115	0·39
2N727	0·50	2N2369	0·27	2N3638	0·17	2N4121	0·27	2N5248	0·44	40409	0·82	BC109C	0·18	BC179C	0·26	BC213LB	0·17	BC547	0·13	BD240C	0·59	BF160	0·33
2N914	0·38	2N2369A	0·27	2N3638A	0·17	2N4122	0·27	2N5294	0·44	40410	0·82	BC140	0·30	BC182	0·12	BC213LC	0·17	BC547A	0·13	BD241A	0·49	BF161	0·65
2N916	0·33	2N2646	0·80	2N3702	0·14	2N4123	0·19	2N5295	0·44	40411	3·10	BC141	0·32	BC182A	0·12	BC214	0·17	BC547B	0·13	BD241C	0·65	BF167	0·37
2N917	0·38	2N2647	1·55	2N3703	0·14	2N4124	0·19	2N5296	0·44	40594	0·87	BC147	0·13	BC182B	0·13	BC214B	0·17	BC548	0·13	BD242A	0·55	BF173	0·37
2N918	0·45	2N2903	1·60	2N3704	0·14	2N4125	0·19	2N5298	0·44	40595	0·98	BC147B	0·13	BC182L	0·15	BC214C	0·17	BC549	0·14	BD242C	0·62	BF177	0·27
2N929	0·37	2N2904	0·31	2N3705	0·14	2N4126	0·19	2N5447	0·16	40673	0·80	BC148	0·13	BC182LA	0·15	BC214L	0·18	BC549B	0·14	BD243A	0·65	BF178	0·27
2N929A	0·37	2N2904A	0·31	2N3706	0·14	2N4284	0·38	2N5448	0·16	40669	1·30	BC148B	0·13	BC182LB	0·15	BC214LB	0·18	BC549C	0·15	BD243C	0·87	BF179	0·33
2N930	0·37	2N2905	0·31	2N3707	0·14	2N4286	0·22	2N5449	0·20	AC126	0·48	BC148C	0·13	BC183	0·12	BC214LC	0·18	BC557	0·14	BD244A	0·70	BF180	0·37
2N930A	0·95	2N2905A	0·31	2N3708	0·12	2N4287	0·22	2N5457	0·38	AC127	0·48	BC149	0·15	BC183A	0·12	BC237B	0·15	BC558	0·13	BD244C	0·87	BF181	0·37
2N1711	0·30	2N2906	0·25	2N3709	0·12	2N4288	0·22	2N5458	0·35	AC128	0·48	BC149C	0·15	BC183B	0·13	BC238A	0·13	BC559	0·15	BD245A	0·69	BF182	0·37
2N1889	0·30	2N2906A	0·25	2N3771	2·16	2N4289	0·22	2N5459	0·32	AC151	0·43	BC157A	0·15	BC183C	0·13	BC238B	0·13	BCY70	0·21	BD245C	0·85	BF183	0·44
2N1890	0·30	2N2907	0·25	2N3772	2·20	2N4347	2·20	2N5460	0·65	AC152	0·54	BC158A	0·15	BC183L	0·15	BC238C	0·13	BCY71	0·26	BD246A	0·72	BF184	0·41
2N1893	0·30	2N2907A	0·25	2N3773	3·15	2N4348	2·65	2N5484	0·37	AC153	0·59	BC158B	0·15	BC183LA	0·15	BC239B	0·16	BCY72	0·18	BD246C	0·93	BF185	0·37
2N2102	0·50	2N2923	0·17	2N3819	0·36	2N4918	0·65	2N5485	0·40	AC153K	0·59	BC159A	0·17	BC183LB	0·15	BC239C	0·17	BD115	0·88	BD433	0·44	BF194	0·16
2N2192	0·58	2N2924	0·17	2N3820	0·39	2N4919	0·70	2N5486	0·40	AC176K	0·70	BC159B	0·17	BC183LC	0·15	BC257A	0·18	BD131	0·55	BD434	0·46	BF195	0·16
2N2193	0·50	2N2925	0·19	2N3821	0·96	2N4920	0·83	2N5490	0·64	AC176	0·54	BC160	0·38	BC184	0·12	BC258B	0·19	BD132	0·75	BD435	0·46	BF196	0·16
2N2193A	0·52	2N2926	0·17	2N3900	0·28	2N4921	0·54	2N5492	0·64	AC187	0·59	BC161	0·38	BC184B	0·13	BC259B	0·19	BD135	0·40	BD436	0·46	BF197	0·18
2N2194	0·42	2N3053	0·25	2N3901	0·30	2N4922	0·60	2N5494	0·65	AC187K	0·65	BC167	0·13	BC184C	0·13	BC300	0·43	BD136	0·40	BD437	0·55	BF198	0·19
2N2194A	0·45	2N3054	0·72	2N3903	0·20	2N4923	0·75	2N5496	0·67	AC188	0·54	BC167B	0·13	BC184L	0·15	BC301	0·43	BD137	0·41	BD438	0·55	BF199	0·19
2N2195	0·40	2N3055	0·75	2N3904	0·18	2N4924	1·15	2N6027	0·64	AC188K	0·65	BC168A	0·13	BC184LB	0·15	BC302	0·37	BD138	0·41	BD529	0·49	BF224J	0·22

LINEAR CIRCUITS

CA3018	0·75
CA3018A	1·10
CA3020	2·20
CA3020A	2·50
CA3028A	0·90
CA3028B	1·25
CA3030	1·50
CA3030A	2·20
CA3038	2·90
CA3038A	4·10
CA3045	1·55
CA3046	0·77
CA3048	2·45
CA3052	1·78
CA3080	0·85
CA3080A	2·10
CA3086	0·50
CA3088B	1·87
CA3089B	2·90
CA3090Q	4·40
CA3130	1·06
CA3140	1·04
LM301	0·30
LM307N	0·50
LM308N	0·95
LM309KC	1·95
LM317K	3·35
LM318N	2·45
LM32015	2·16
LM320112	2·15
LM320115	2·15
LM320124	2·15
LM320P5	1·15
LM320P12	1·15
LM320P15	1·15
LM320P24	1·15
LM323K	6·95
LM339N	0·60
LM34015	0·88
LM340115	0·88
LM340124	0·88
LM341P5	0·80
LM341P12	0·80
LM341P15	0·80
LM341P24	0·80
LM348N	0·95
LM358N	0·60
LM360N	3·00
LM370N	3·30
LM371H	2·35
LM350K	6·45
LM373N	3·35
LM374N	3·36
LM377N	1·80

LM378N	2·40
LM379S	4·25
LM380N8	0·96
LM380N14	1·08
LM381AN	2·70
LM381N	1·69
LM382N	1·32
LM384N	1·55
LM386N	0·88
LM387N	1·10
LM388N	1·00
LM389N	1·00
LM702C	0·81
LM709	0·70
LM7098	0·50
LM70914	0·49
LM710	0·67
LM71014	0·64
LM711CN	0·72
LM723C	0·75
LM723C14	0·45
LM726	5·80
LM741C	0·70
LM741C8	0·30
LM741C14	0·30
LM747CN	0·99
LM7488	0·50
LM74814	0·90
LM1303N	1·15
LM1304N	1·52
LM1305N	1·52
LM1307N	1·22
LM1310N	2·10
LM1351N	1·30
LM1458N	0·45
LM1496N	0·97
LM1808N	2·10
LM1812N	6·20
LM1820N	1·16
LM1828N	1·90
LM1830N	1·90
LM1841N	1·90
LM1845N	1·50
LM1848N	1·98
LM1850N	1·90
LM1889N	4·90
LM3301N	0·60
LM3302N	0·55
LM3401N	0·55
LM3900N	0·68
LM3905N	1·15
LM3909N	0·78
LM3911N	1·10
LM7805K	1·75

LM7812K	1·75
LM324	0·75
LM7815K	1·75
LM7824K	1·75
LM78L0602	0·30
LM78L1202	0·30
LM78L15C2	0·30
MM5314	4·60
MM5316	4·60
NE555	0·33
NE556	0·85
NE558N	1·98
NE560	4·50
NE561	4·50
NE562	4·50
NE565	1·39
NE566	1·75
NE567	1·90
NE571N	4·95
SAS60	2·70
SAS70	2·70
SAJ110	2·10
SO41P	1·35
SO42P	1·35
SN76001N	1·30
SN76003N	2·38
SN76013N	1·50
SN76023N	1·50
SN76033N	2·35
TAA263	1·35
TAA300	3·70
TAA320A	1·15
TAA350A	3·00
TAA521	1·10
TAA522	2·10
TAA550	0·48
TAA560	2·10
TAA570	2·20
TAA370A	5·45
TAA630	2·40
TAA960	3·90
TAA970	4·20
TAA611B	2·50
TAA621	2·50
TAA661A	1·65
TAA661B	1·45
TAA700	4·50
TAA930A	1·45
TAA930B	1·45

TAD100	2·00
TBA120	0·80
TBA500	2·24
TBA500Q	2·34
TBA510	2·35
TBA510Q	2·48
TBA520	2·60
TBA520Q	2·70
TBA530	2·35
TBA530Q	2·45
TBA540	2·60
TBA540Q	2·70
TBA550	3·60
TBA550Q	3·80
TBA5600Q	3·00
TBA570	2·10
TBA570Q	2·20
TBA700Q	2·20
TBA720AQ	2·06
TBA750	2·36
TBA750Q	2·45
TBA800	1·30
TBA810S	1·30
TBA820	0·80
TBA920	2·99
TCA160C	2·36
TCA160B	2·55
TCA270	2·99
TCA730	4·50
TCA740	4·50
TCA750	3·00
TCA760	2·00
TCA105	1·49
TCA440	1·65
TDA1022	7·50
TDA1024	1·24
TDA1034	4·75
TDA2020AD	4·50
UAA170	2·15
UAA180	2·15
TL080CP	1·25
TL081CP	0·90
TL082CP	1·10
TL083CN	1·40
TL084CN	1·45
LF355N	0·80
LF356N	0·80
LF357N	0·80
LF13201N	3·00
LF13331N	3·00
LF13741H	0·80
LF13741N	0·55

SPECIALIST CONSUMER NEW CATALOGUE

Stocking Distributors Officially Appointed

NATIONAL	**VERO**
TEXAS	**ANTEX**
MULLARD	**ELECTROLUBE**
SIEMENS	**SIFAM**
SESCOSEM	**ARROW HART**

Makes components buying easy

AVAILABLE NOW

40 PAGES

Our new Spring catalogue is now available—contains all you need and more—packed with over 8,500 items with lots of new products and ideas. New enlarged 40 pages with special offers, discounts and data. Available from any branch at 45p or 35p to callers.

CMOS

4000	0·22
4001B	0·22
4002	0·22
4006	1·25
4007	0·22
4008B	0·99
4009	0·58
4010	0·58
4011B	0·22
4012	0·22
4013B	0·52

4014	1·00
4015	1·05
4016	0·52
4017B	1·05
4018B	1·05
4019B	0·52
4020B	1·15
4021	1·05
4022B	1·00
4023B	0·22
4024B	0·76
4025B	0·22
4027B	0·55

4028B	0·92
4029B	1·10
4030	0·84
4031B	2·25
4035B	1·30
4037	1·20
4041B	0·85
4042B	0·86
4043	1·05
4044	1·00
4045	1·76
4046B	1·50
4047B	0·96

4049	0·96
5050B	0·85
4051B	0·85
4052B	0·86
4053B	0·98
4054	1·48
4055	1·65
4056	1·65
4059	6·00
4060B	1·15
4063	1·35
4066B	0·75
4067	4·85

4068	0·27
4069B	0·24
4070B	0·85
4071B	0·24
4072	0·27
4073B	0·24
4075B	0·24
4076B	0·99
4077	0·70
4078	0·27
4081B	0·24
4082	0·27
4085	0·89

4086	0·89
4089B	2·10
4093B	1·00
4094	2·30
4095	1·30
4096	1·30
4097	4·65
4098	1·00
4510B	1·20
4511	1·75
4516	2·10
4518B	1·20

TTL & CMOS

74LS153N	0·58
74LS154N	1·45
74LS155N	1·20
74LS156N	1·20
74LS157N	0·60
74LS158N	0·65
74LS160N	1·43
74LS161N	0·85
74LS162N	1·43
74LS163N	0·85
74LS164N	1·43
74LS168N	2·43
74LS169N	2·43
74LS174N	1·33
74LS175N	1·26
74LS181N	3·95
74LS189N	3·74
74LS190N	1·00
74LS191N	1·00
74LS192N	1·98
74LS193N	1·98
74LS196N	1·28
74C00N	0·24
74C02N	0·24
74C04N	0·24
74C08N	0·24
74C10N	0·24
74C14N	1·41
74C20N	0·24
74C30N	0·24
74C32N	0·24
74C42N	0·92
74C48N	1·38
74C73N	0·54
74C74N	0·56
74C76N	0·54
74C83N	1·30
74C85N	1·30
74C86N	0·64
74C89N	4·39
74C90N	0·85
74C93N	0·85
74C95N	1·04
74C107N	1·22
74C150N	4·14
74C151N	2·47
74C154N	3·68
74C157N	2·21
74C160N	1·11
74C161N	1·11
74C162N	1·11
74C163N	1·11
74C164N	1·04
74C165N	1·04

74C173N	0·90
74C174N	0·90
74C175N	0·90
74C192N	1·11
74C193N	1·11
74C195N	1·04
7400N	0·17
7401N	0·17
7402N	0·17
7403N	0·17
7404N	0·17
7405N	0·22
7406N	0·56
7407N	0·55
7408N	0·22
7409N	0·22
7410N	0·20
7411N	0·26
7412N	0·20
7413N	0·36
7414N	0·80
7416N	0·36
7417N	0·36
7420N	0·22
7423N	0·32
7425N	0·32
7427N	0·32
7430N	0·22
7432N	0·30
7437N	0·35
7438N	0·32
7440N	0·20
7441AN	0·84
7442N	0·76
7445N	1·40
7446AN	0·90
7447AN	0·80
7448N	0·80
7450N	0·22
7451N	0·22
7453N	0·22
7454N	0·22
7460N	0·22
7470N	0·46
7472N	0·30
7473N	0·44
7474N	0·32
7475N	0·80
7476N	0·45
7480N	0·60
7481N	1·00
7482N	0·90
7483N	1·05
7484N	1·20

7485N	1·36
7486N	0·36
7489N	2·45
7490AN	0·45
7491AN	0·85
7492N	0·45
7493N	0·45
7494N	0·90
7495N	0·76
7496N	0·70
7497N	1·95
74100N	1·40
74107N	0·35
74118N	0·95
74119N	1·40
74121N	0·28
74122N	0·55
74123N	0·55
74125N	0·45
74141N	0·86
74148N	1·35
74145N	0·86
74150N	1·20
74151N	0·76
74153N	0·76
74154N	1·20
74155N	0·70
74157N	0·78
74160AN	1·10
74161AN	1·10
74162AN	1·10
74163AN	1·10
74164N	1·36
74165N	1·36
74167N	2·50
74174N	1·60
74175N	1·00
74176N	0·90
74177N	0·90
74180N	1·00
74181N	2·00
74182N	0·80
74185N	1·50
74185AN	1·50
74188AN	3·25
74189N	2·60
74190N	1·40
74191N	1·20
74192N	1·20
74193N	1·20
74196N	1·20
74197N	1·00
74198N	2·00
74199N	2·00

LEDS + OPTO

Displays 7 seg com anode or cath Red

8mm HT	£1·50
10mm HT	£1·55
14mm HT	£1·57
18mm HT	£1·85

LEDS	Red	Gr	Yell
Small 3mm	·18	·19	·19
Large 5mm	·20	·20	·20
xtra bright	·40	·40	·40

I/red LD271	£0·55
IR receiver	£1·45
Opto coupler	£1·55

Full range + data in our 1978 catalogue

NATIONWIDE SERVICE

Crystals	Meters
Valves	Tools
Chokes	Sprays
Knobs	Presets
Cables	Neons
Fuses	Heatsinks
Cases	Indicators

VAT inclusive prices

For all EE Projects

DIL SKTS

Low profile IC skts

8 pin	**15p**	22 pin	**30p**
14 pin	**16p**	24 pin	**35p**
16 pin	**18p**	28 pin	**45p**
18 pin	**27p**	40 pin	**55p**

FULL RANGE OF
Capacitors Diodes
Resistors Cables
Plugs/skts Cases
Meters Clocks
in our new catalogue

TRIACS plastic pack 400v TO220

Texas		12 amp	**93p**
4 amp	**72p**	16 amp	**£1·31**
6 amp	**77p**	20 amp	**£1·87**
8 amp	**82p**	25 amp	**£2·20**

THRYRISTORS plastic power

4 amps		8 amps		12 amps	
100v	**0·38**	100v	**0·47**	100v	**0·63**
200v	**0·44**	200v	**0·54**	200v	**0·70**
400v	**0·54**	400v	**0·68**	400v	**0·90**

Branded Texas quality product

CONVERT TV SET TO TELETYPE

The new CRT control chip from Thomson CSF SFF96364. Convert your TV set into an electronic teletype—16 lines × 64 characters, requires RAM, character generator & little else for a basic teletype. Available as chip or full display card. Full cursor control, 5 volts TTL compatible, line erase, full card includes UART, Modem, char, gen etc. comp video out from encoded keybd in.

NEW chip **£17·20**
Full card **£151·00**

★MAIL ORDER★

Express service on all orders, please add 40p for p&p to all orders. Tel orders on credit cards £10 minimum.

Buy it with Access

BARCLAYCARD VISA

3½ DIGIT PANEL METER KIT

INTERSIL

LCD Display
Batt operated
Contains all components required for construction plus PCB. Auto vero extremely versatile and accurate—easy assembly kit.

NEW!

£26·99

CLOCK MODULES DIGITAL

12 08

Built and tested—requires only switches and transformer to complete 12 or 24hr alarm modules

MA1002F 12hr 5in display	10·45
MA1002H 24hr 5in display	10·45
MA1010E 12hr 84in display	13·75
MA1010G 24hr 84in display	13·75

CAR CLOCK MODULE

MA1003 Built Tested 12V supply and four-digit module. Crystal controlled

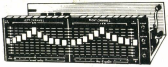
Data Sheet 5p + SAE

MAPLIN

everything for the modern D.I.Y. electronics enthusiast and more.

100W RMS STEREO DISCO

A genuine 100W RMS per channel (both channels driven) stereo disco with auto fade on microphone, VU meters, full monitoring and cueing facilities and a very high quality light show. Complete construction booklet MES41 price 25p. Cabinet comes complete with lid and carrying handles.



10 CHANNEL STEREO GRAPHIC EQUALISER

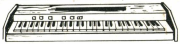
A new design with no difficult coils to wind, but a specification that puts it in the top-flight hi-fi class. All this for around £70 including fully punched and printed metalwork and woodwork. Send for our component schedule now. Full construction details price 25p. (All prices include V.A.T. and p & p.)

'PE' STRING ENSEMBLE

Unbeatable prices and finest quality components only when you buy from Maplin. All parts available to build this fascinating project. Component schedule available shortly (s.a.e. appreciated). Demonstration model in our shop soon. Phone now and compare our prices.

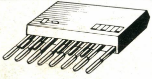
VERY LOW-DISTORTION AUDIO OSCILLATOR

The very low distortion sine wave (<0·01%) output is suitable for testing very high quality hi-fi audio equipment. Also includes square wave output. Range 20Hz to 26kHz. Output 0V to 1V in three continuously variable steps. Total cost around £21. Full construction details in our catalogue. Send the coupon below, now! (all prices include V.A.T. and p & p).



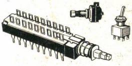
TOUCH-SENSITIVE PIANO

The revolutionary new IC AY-1-1320 first seen on 'Tomorrow's World' is now available. Complete kit of IC's to build a 60-note piano (18 × IC's) order as HQ53H price £36·86. Preliminary circuit details in our October newsletter. Complete design, pcb's attractive veneered wooden cabinet available soon. It's the most realistic-sounding electronic piano we've ever heard and includes simulated damping, loud and soft pedals. Full details in our newsletters. (All prices include V.A.T. and p & p.)



PEDAL UNIT

A completely self-contained pedal unit. 13-note. 2-Octave range. 4 organ stops. It can be added to any organ. A really unusual extra is the bass guitar stop which uses four envelope shapers to give a real bass guitar sound. A must for the solo guitarist. Full construction details in our catalogue—post the coupon below, now!

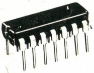


SWITCHES

We stock a wide range of switches including a really low-priced high quality interlocking push-button switch system which is extremely versatile. We've got toggle switches, slide switches, push switches, rotary switches—there are dozens to choose from, but it's only a tiny part of our fantastic range.

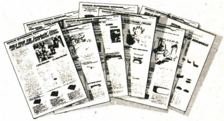
SYNTHESISER

The International 4600 Synthesiser. A very comprehensive unit. Over 400 sold. We stock all the parts costing less than £500 including fully punched and printed metalwork and a smart teak cabinet. Far less than half what you'd pay for a ready made synthesiser of equal quality. Specification on request. Full construction details in our construction book £1·50. (All prices include V.A.T. and p & p.)



INTEGRATED CIRCUITS

Over 35 pages in our catalogue devoted to hundreds of useful IC's. All with data, pin connections and many with applications circuits and projects to build. Post the coupon now!



Our bi-monthly newsletter keeps you up to date with latest guaranteed prices – our latest special offers – details of new projects and new lines. Send 30p for the next six issues (5p discount voucher with each copy).

IT'S A FANTASTIC BESTSELLER!

216 big (11" x 8") pages! Over a thousand illustrations! Over 30 pages of complete projects to build! Thousands and thousands of useful components described and illustrated! No wonder it's a bestseller!

DON'T MISS OUT! SEND 60p NOW!

MAPLIN ELECTRONIC SUPPLIES
P.O. BOX 3 RAYLEIGH ESSEX SS6 8LR
Telephone: Southend (0702) 715155
284, London Road, Westcliff-on-Sea, Essex
on Monday) Telephone: Southend (0702) 715157

POST THIS COUPON NOW FOR YOUR COPY OF OUR CATALOGUE PRICE 60p

Please rush me a copy of your 216 page catalogue
I enclose 60p, but understand that if I am not completel
satisfied I may return the catalogue to you within
14 days and have my 60p refunded immediately.

NAME ____________________

ADDRESS ____________________

EE